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January 1995

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Signal Theft

How big a problem is it?

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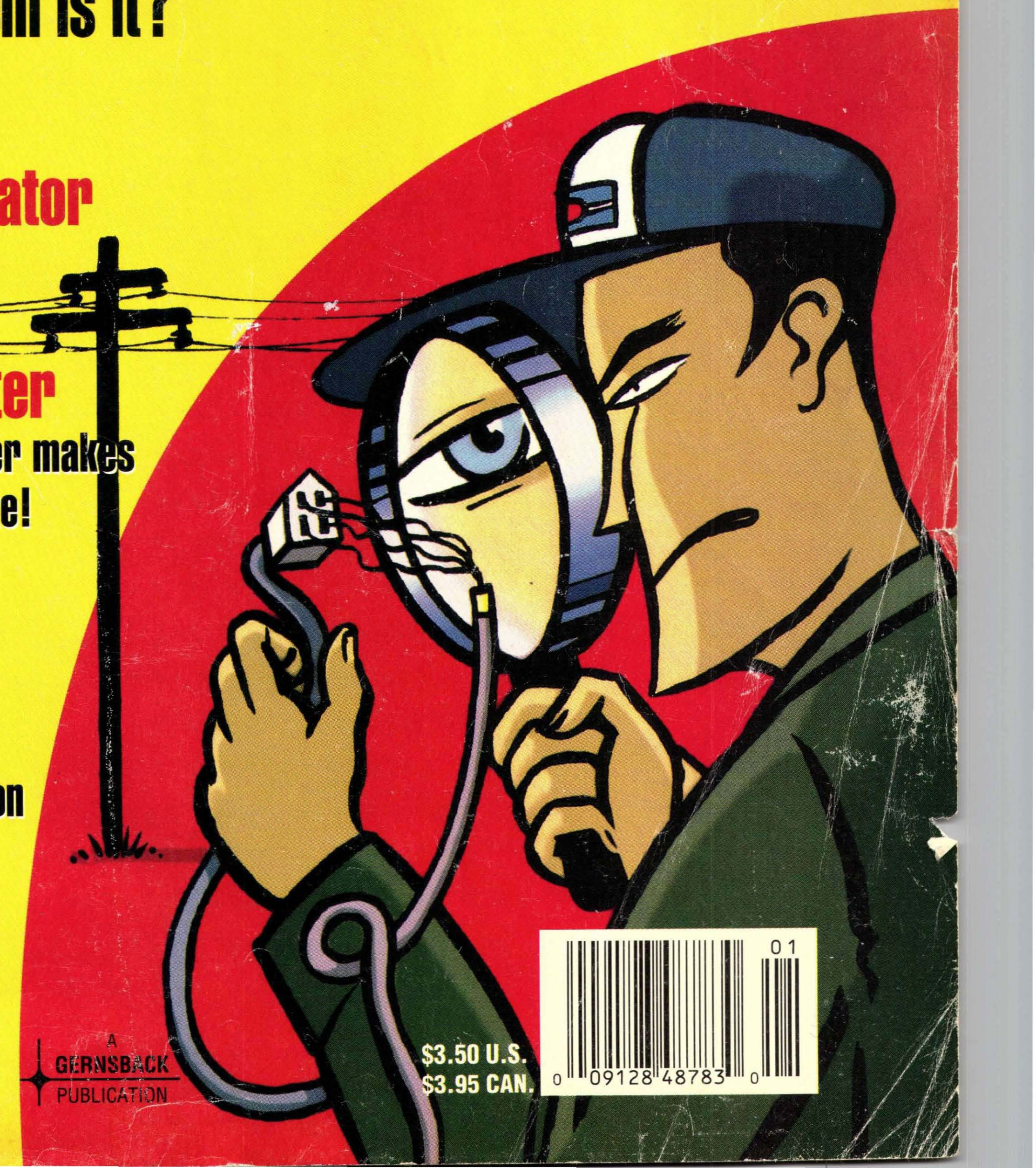
Remote Control Problems?

Interference might be causing erratic operation

Isolation Transformer

A must-have tool for any workbench



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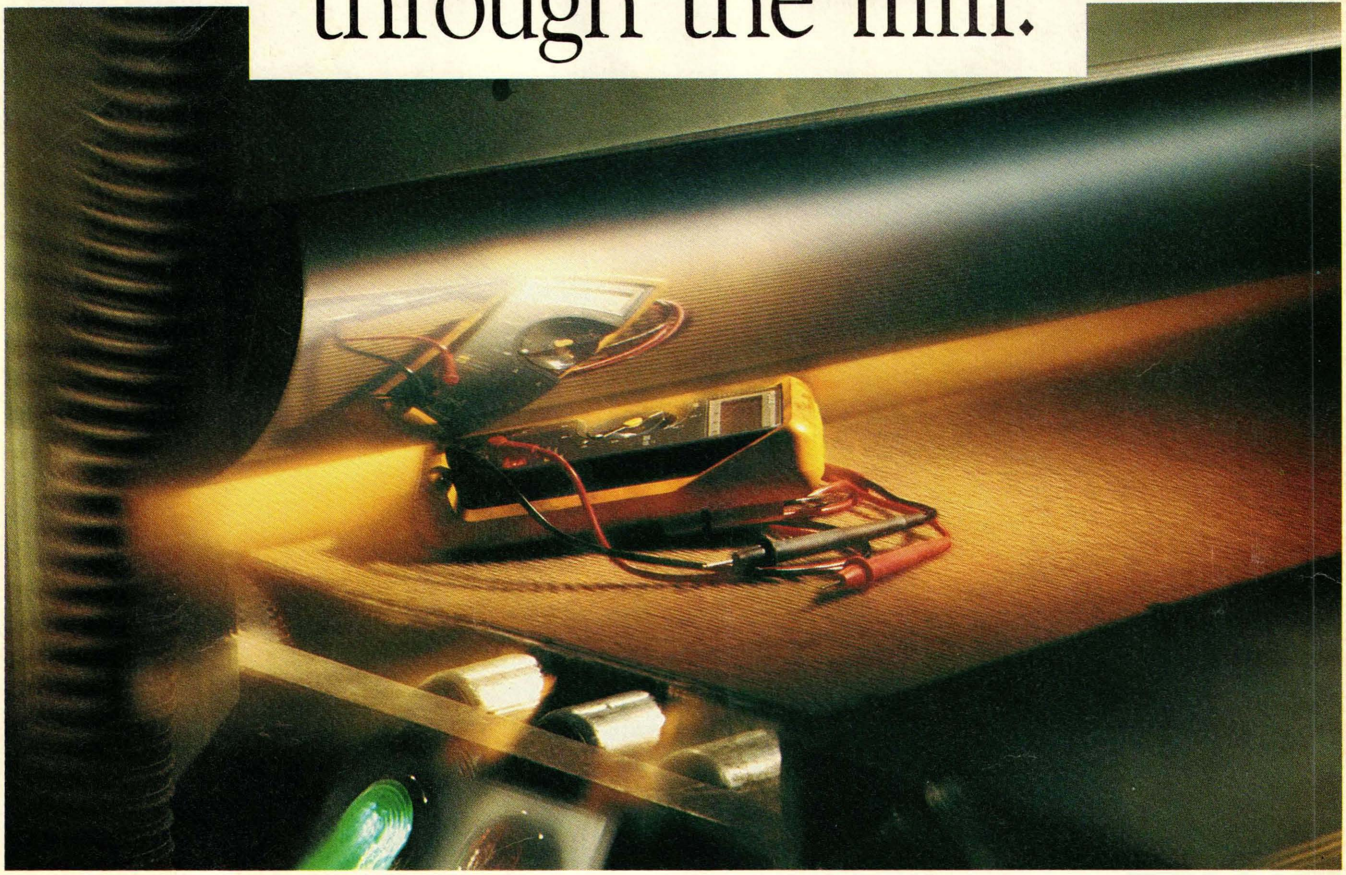

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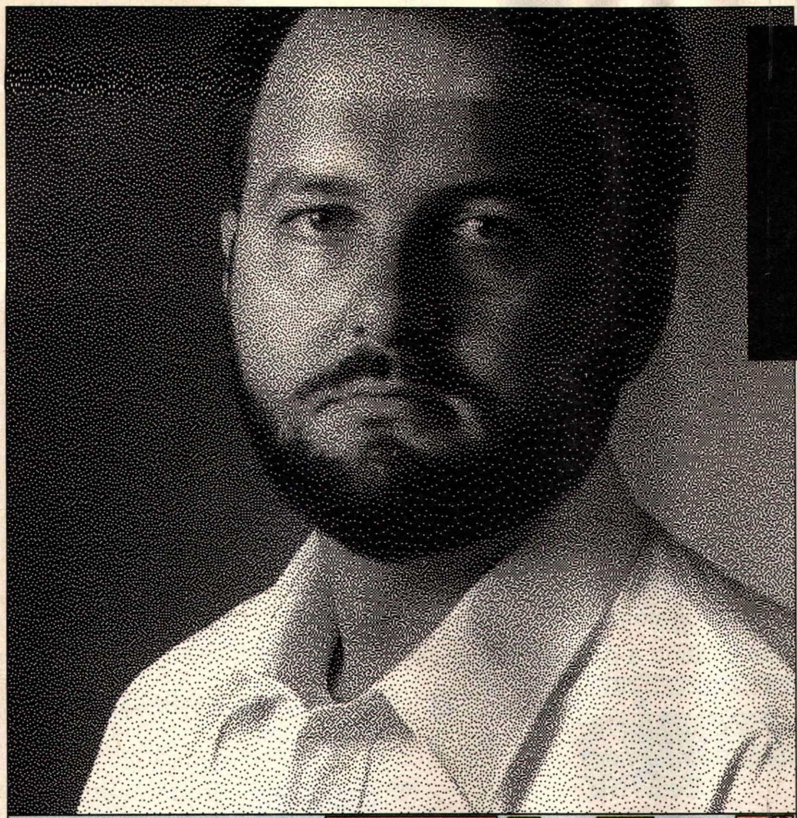

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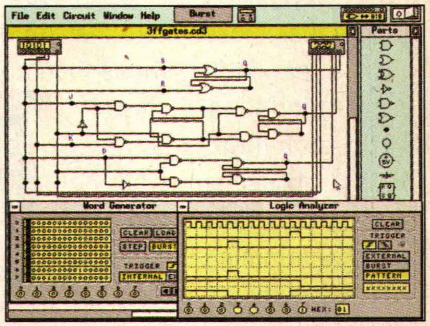

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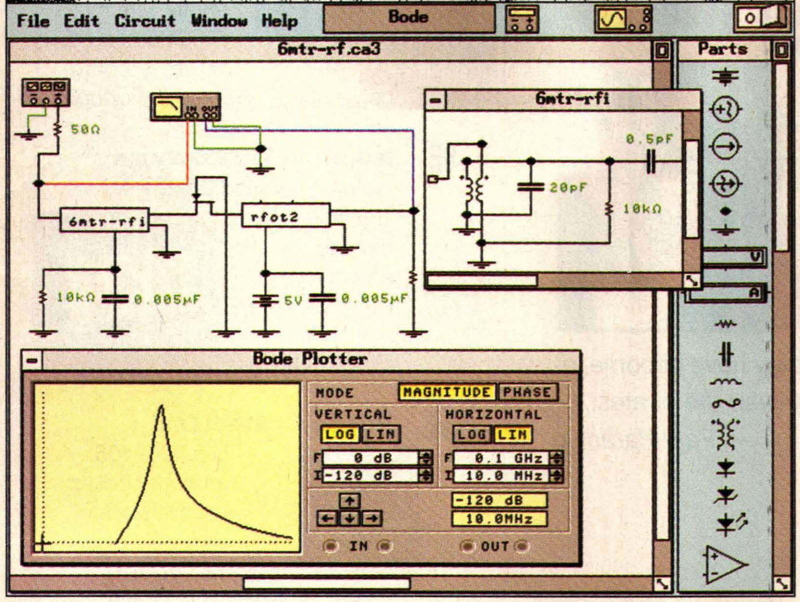

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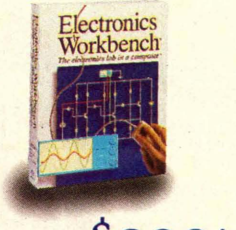

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Vol. 66 No. 1

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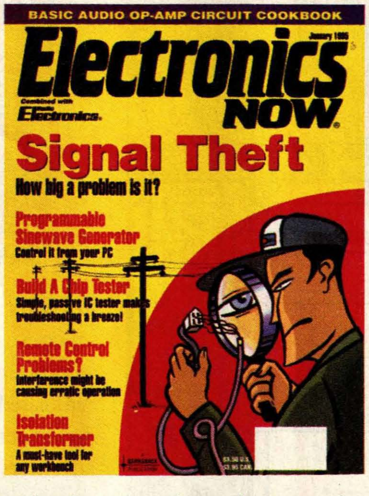
ON THE COVER

35 BUILD THE RETRO-REMOTE

Signal theft has been around ever since signal scrambling was introduced. Today, the cable industry estimates that it loses more than $4 billion to signal pirates each year. More serious than an individual pirating a cable signal are the commercial establishments who redistribute programming to others for a fee, and cable company employees who do their part to make a quick buck. As the cable and satellite-TV industries prepare for new, interactive technologies, they have become increasingly aggressive in trying to thwart the pirates.

— *Paul Paradise*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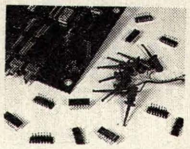
Remote Control Problems?
Interference might be causing erratic operation
Isolation Transformer
A must-have tool for any workbench

BUILD THIS

40 CHIP TESTER



This inexpensive IC tester is easy to build, and yet quite versatile. — *Mark Hanslip*

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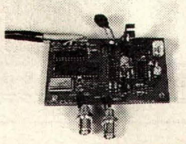

Generate sinewaves on the fly with this circuit and a PC or single-board computer. — *Ronald J. Portugal*

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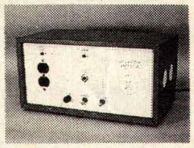

Isolate yourself from the AC line when you service electronic equipment. — *Doyle Whisenant*

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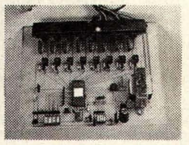

Use a 68705 microcontroller to control eight channels of 120-volt AC power. — *Richard L. Roane*

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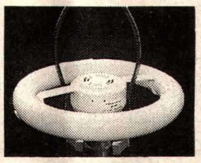

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O-Scope I
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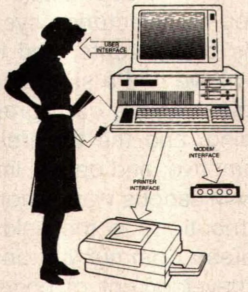
O-Scope I



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WHAT'S NEWS

A review of the latest happenings in electronics.

AMD to offer Pentium Processors

Advanced Micro Devices Inc. (AMD) intends to go head-to-head with Intel Corporation again over a new generation of microprocessors. It recently announced that it expects to begin volume production of Pentium-like MPU chips by the middle of the year. AMD, which already makes functional equivalents of Intel's 486 MPU, said its new K5 device was twice as fast as Intel's Pentium and would be compatible with Windows software from Microsoft Corporation.

1994 National Medal of Technology winners

Four persons and two companies received the 1994 National Medal of Technology in recognition of their contributions to America's technical innovation and economic competitiveness. The Presidential Awards were granted by Commerce Secretary Ronald H. Brown to Amgen (Thousand Oaks, CA), Corning, Inc. (Corning, NY), Joel S. Engel (Ameritech Corp), Richard H. Frenkiel (AT&T Consumer Products), H. Joseph Gerber (Gerber Scientific), and Irwin M. Jacobs (Qualcomm).

Amgen, the world's largest biotech firm, was granted a medal for its development of innovative medications for critically ill patients based on cellular and molecular biology. Amgen scientists discovered and introduced genetically engineered human erythropoietin, or Epogen, a protein essential to the maturation of oxygen-carrying red blood cells.

Epogen, for treating anemia in kidney dialysis patients, has virtually eliminated the patient's need for blood transfusions. Another Amgen-developed product is Neupogen, a recombinant protein that stimulates the production of infection-fighting white blood cells. Neupogen decreases possible infection associated with chemotherapy.

Corning, well known for its glass products, was honored for its technical innovations over the past 125 years. A Corning glass envelope enclosed Edison's first incandescent light bulb and fiber optic cables from the company are now replacing copper wires in telephony and communication. Corning has also participated in such scientific activities as providing the windows for America's space shuttle, mirrors for giant telescopes, and ceramic filters for pollution control.

Joel Engel and Richard Frenkiel were jointly honored for their fundamental contributions to the theory, design, and distribution of cellular mobile communications systems. Their work led to important advances in local area networks as well as worldwide communications based on satellites.

Joseph Gerber's medal was for past and on-going invention, development, and commercialization of efficient, cost-effective automated manufacturing systems. He holds 600 patents, and his inventions have had a significant impact on electronics, cartography, ship building, and the apparel, aircraft, automotive, and optical industries.

Irwin Jacobs was honored for his contributions to the field of digital wireless communications and for his development of code- division multiple access (CDMA), a U.S. standard for cellular digital communications. He and his colleagues developed a television signal scrambling system, as well as innovations that will improve the next generation of cellular telephones and personal computers. Mr. Jacobs also developed a data-transmission and vehicle location system based on satellites for the trucking and shipping industries.

Commerce Secretary Brown declared, "Their achievements have contributed to U.S. economic prosperity and job creation while benefiting millions of people at home and around the globe. The dedication, energy, and unique creativity of each honoree should serve to inspire and motivate all Americans. Each medalist deserves special recognition as models for the new American economy."

More advanced semiconductor IC plants

The Fujitsu-Advanced Micro Device (AMD) joint venture (FASL) has opened a factory for the production of flash memories in Japan. The memory devices will be fabricated with 0.5-micron design rules.

FASL expects that the $750-million plant, at full production, will produce more than 5000 eight-inch silicon wafers weekly. The 280,000-square foot plant is expected to employ somewhere around 400 people when it is fully operational

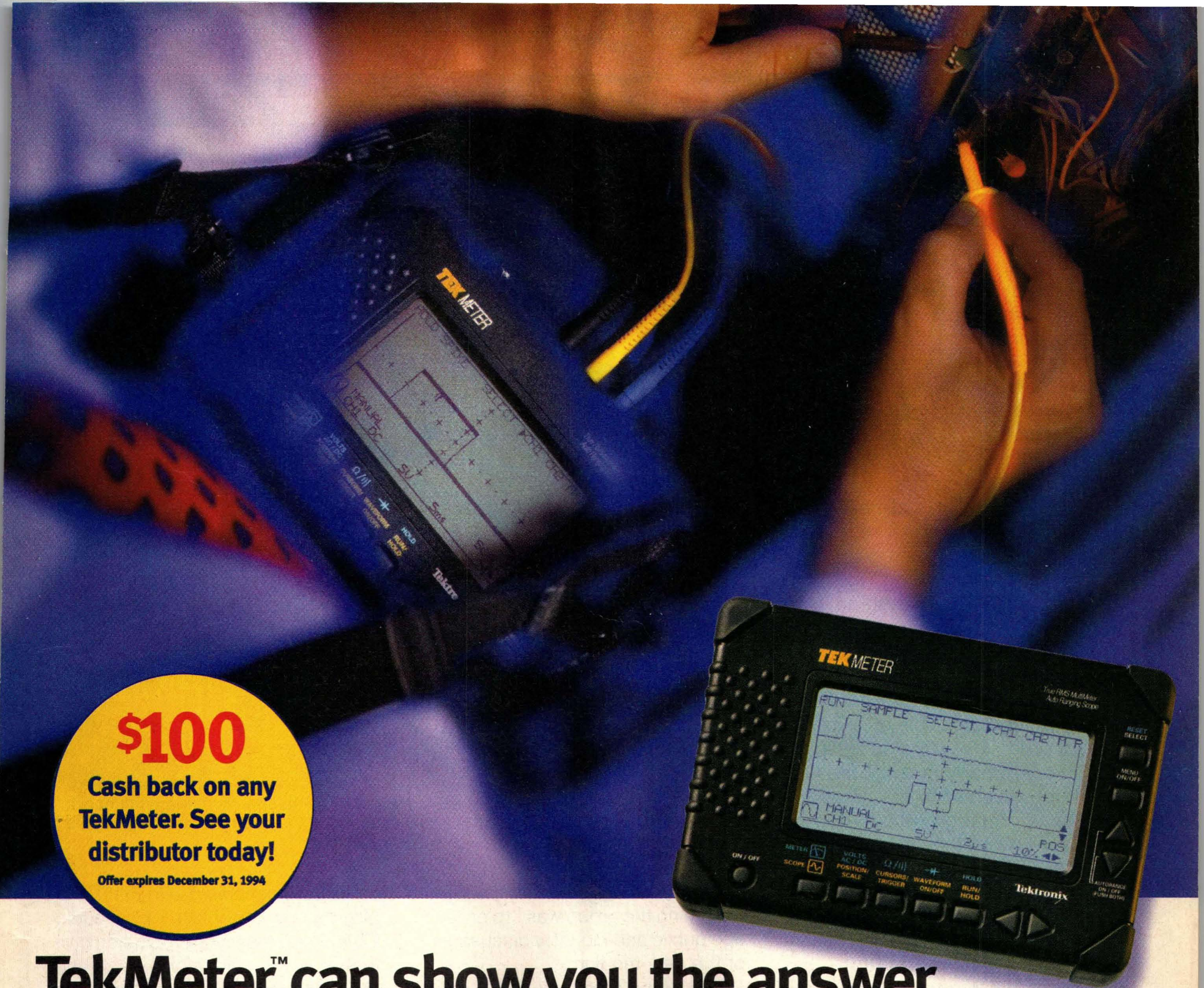
In a related announcement, Micron Technology said that it would spend $1.3 billion to build a new 200-acre manufacturing plant, probably at Boise, Idaho, where the company is now based. The largest expansion ever, the plant would double the company's manufacturing capacity. Construction of the new plant is expected to begin in the first quarter of 1995 and it is expected to employ 3500 people when it is complete.

Wavetek to Acquire a Schlumberger Division

Wavetek Corp. has agreed to acquire the worldwide assets of the Schlumberger Communications Test Division (CTD). These include both the Radio Communications Test Equipment Business located in Germany and the Telecommunications Test Equipment business located in France.

CTD developed the first modular test set capable of testing all kinds of radio communications systems. It now builds test equipment for video transmission, data communication, and fiberoptic networks. Schlumberger will retain a minority interest in the business.

(Continued on page 16)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CIRCLE 92 ON FREE INFORMATION CARD

VIDEO NEWS

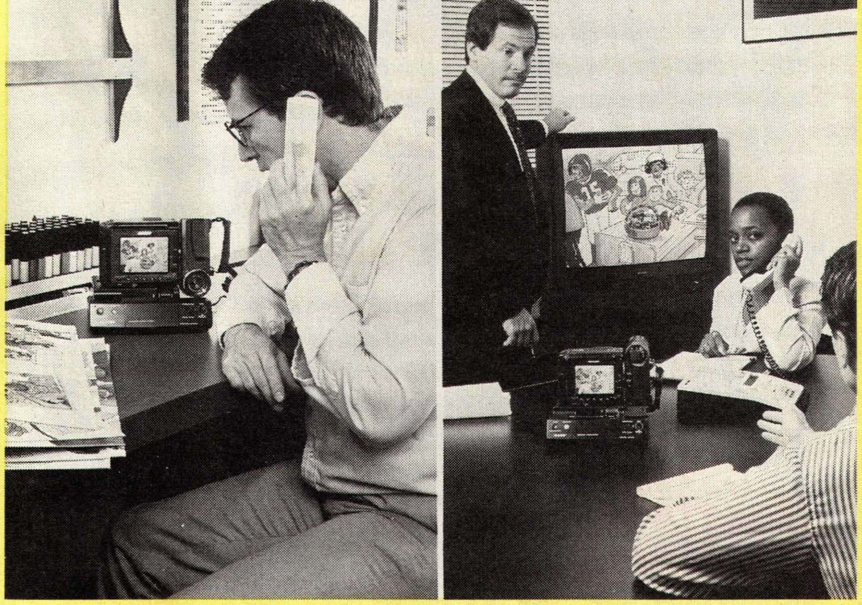
What's new in the fast-changing video industry.

DAVID LACHENBRUCH

• Network indexer. ABC will make it easier to index your videotapes, according to current plans. The network has agreed to broadcast "Index Plus" information during the vertical blanking interval (VBI) of its broadcasts. The data that its affiliated stations will send out will trigger specially equipped VCRs to record its programs and make a record of the programs recorded, which can be displayed on-screen. For subsequent viewing, the VCR owner can select any program from an on-screen directory and push a remote-control button. Presto—the VCR advances to the proper point and begins playback. The system also makes it possible to display a list of programs with a guide showing the volume number of the cassette on which each is recorded.

The information transmitted by ABC will be on the "extended data service" (EDS) portion of the VBI—which actually is filed number 2 of the closed-caption line, number 21. The system also will provide continuous program information—the name of the program, a brief description, and time remaining—as an aid to channel surfers. Whether or not to transmit that information is up to ABC's affiliated stations. Index Plus was invented by Gemstar Development Corporation, the company responsible for the highly successful VCR Plus+ recording system. The only known previous use of the EDS line is its employment by PBS affiliates to set the clocks on three current-model Sony VCRs (*Electronics Now*, August 1994).

• Hollywood likes DVD. Seven major movie studios have formed an "ad hoc advisory group" on the digital video disc (DVD), the upcoming medium designed to record 135 minutes of high-resolution video on a single five-inch disc. Columbia Pictures, Disney, MCA/Universal, MGM, Viacom, Paramount, and Warner Brothers said that their goal in forming the group was "to encourage public and industry discussion" of the new medium.



TELECONFERENCING TAKES ON NEW MEANING with Sharp's Viewcamteleport, which allows the transmission of full-color still video images over ordinary phone lines.

The group listed six major goals for DVD: (1) It must accommodate a full-length movie on a single disc. (2) Picture quality should be "ideally superior" to that of "current high-end consumer video playback systems," presumably a reference to laserdisc. (3) Audio should be compatible with surround sound and other high-quality systems. (4) It should be able to accommodate three to five different languages on the same disc. (5) Some form of "copy protection" is a must. (6) A parental-lockout system should be built in or, alternatively, the disc should be able to accommodate two versions of the same program.

At our press time, two major systems appeared to be vying for industry standardization. Sony and Phillips are collaborating on one system, whose disc physically appears identical to a standard audio CD and actually has one-way compatibility with audio CD in that DVD players will be able to play audio CDs. The other system is being promoted by an alliance of Toshiba and Time Warner. That system, according to some reports, is the same size as an audio CD but has two sections laminated together (although it's a single-sided disc).

Both the hardware and the software industries are anxious to field a single standard system to avoid a duplication of the Beta–VHS confusion. The advantages of the DVD system presumably include substantial core savings in replication and shipping because of low material use and light weight, higher picture quality—presumably including the ability to display widescreen movies in full width and resolution—and better audio than existing systems.

• Recordable digital discs. While the electronics world awaits definitive word on the specifications for digital video discs, TDK an-

Continued on page 34

How to get surround sound without buying the theater...

Chase Technologies brings you an amazing new patent pending surround sound decoder that turns your stereo into a five-channel home theater.

By Charles Anton

$99 HOME THEATER
SURROUND-SOUND
BREAKTHROUGH!
SUPPORT YOUR LOCAL

As much as I love renting videos, it's just not the same as seeing a movie in a theater. I remember the first time I saw *Jurassic Park*—I nearly jumped out of my seat when the dinosaurs roared. One of the reasons movies seem so real is because surround sound makes it seem like you're actually there when events are happening. Now there's an incredible new device that lets you use a stereo receiver to get that same surround sound in your home.

It takes more than five speakers to get surround sound; there needs to be a way of separating the signals. The new Chase Technologies HTS-1 decoder does just that, and in a revolutionary way that rivals the best Dolby Pro-Logic and THX systems.

Wins over critics. In the September '94 issue of "High Performance Review," noted audio critic Daniel Kumin said "the HTS-1 can do quite a job of recreating a 3D theatrical experience...surround effects emanated with satisfying fullness...sound was clean at any level...with quite involving and natural sound ambience." Plus, John Sunier, the leading authority on surround sound and producer of *Audiophile Audition*, a nationally syndicated radio program for audio enthusiasts, says, "...the new Chase HTS-1, when used to decode the hidden ambience in all musical recordings, definitely outperforms all the Dolby and THX processors (which could cost you up to $3,000)...I am impressed!"

Passive circuit. Last year, audio industry veteran and Chase president Bob Rapoport invented a new five-channel "passive" circuit for decoding every surround sound encoded movie available. This new decoder can be used with two, three, four, or five channels of amplification, making it the most cost effective method for upgrading an existing stereo system to full home theater performance on the market today.

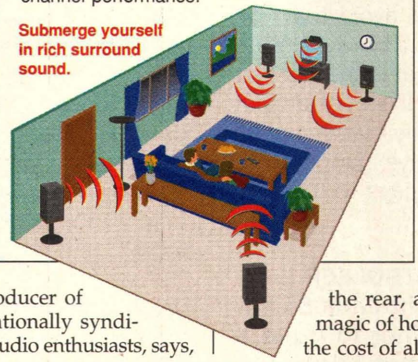
Breakthrough. The HTS-1 is able to decode the *Dolby Surround*™ signals in a stereo, videotape or laserdisc because the spatial and depth cues have been matrixed into the "out-of-phase" L minus R portion of the program. By decoding passively, the HTS-1 avoids costly and noisy signal processing. Plus you don't need any extra amps! Just connect the HTS-1 to your existing stereo, add two speakers for the rear, and you'll experience the magic of home theater at a fraction of the cost of all other systems.

The secret of surround sound

Surround sound has become the rage of the 90's because it adds depth and realism to stereo sound, giving you the home theater experience. It makes you feel like you're actually at a concert or theater. To "fill a room" with surround sound, you need more than two channels. The HTS-1 provides five channels of sound from any two-channel stereo source.

Free center channel. By connecting your VCR or laserdisc player to your TV, you get sound from your TV speaker; this acts as the fifth or "center channel."

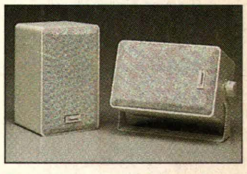
Upgradeable. The new HTS-1 gives you the ability to upgrade by adding the "Dialog" powered center channel speaker (instead of using your TV speaker.) The decoder can also feed an extra amp for the rear speakers if you want the ultimate in discreet five channel performance.



Submerge yourself in rich surround sound.

Easy installation. Hooking up the HTS-1 is easy—just connect the speaker outputs of your receiver or amp to the HTS-1, then connect speaker wire to the front and rear speakers. The rear channel speakers don't have to be big. We suggest the Chase ELF-1 in either black or white finish to match your decor.

Center Channel. The "Dialog" powered center channel speaker is the perfect add-on for home theater. It keeps voices and sound effects centered on screen for stunning localization and clarity.



The ELF-1 rear channel speakers integrate perfectly with the HTS-1.

Risk-free home trial. The best way to evaluate surround sound is in your home, not in a showroom. That's why we're offering this risk-free home trial. We're so sure that you'll be delighted with the quality of these products and the surround sound experience that we are giving you 30 days to try them for yourself. If they're not everything we say, return them for a complete "No Questions Asked" refund.

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HOWLER SUBSTITUTE

I install a lot of office telephone systems, which often requires that I string a lot of cable. It takes a long time to make sure that I have the right wire going to the right frame positions. I was using a "howler" to trace lines, but mine stopped working and it turns out to be an expensive item to replace. Do you have some simple alternative that will do the same job and, if possible, provide several tones to allow me to test more than one wire pair at a time? That last requirement isn't absolutely necessary, but it would save me hours of running up and down the stairs.—A. Spiwak, San Fransisco, CA.

Telephone line howlers are, for my money, too big, too expensive, too noisy, and eat batteries at an unacceptably high rate. For companies that are supposed to be on the cutting edge of technology, some of the equipment seems to be only one step away from steam-powered equipment.

Creating something that will help you trace cable is not only easy, but is also cheap, and the power requirements are so low that the batteries should last almost as long as their rated shelf life—maybe that's a bit of an exaggeration. The circuit shown in Fig. 1 is exactly what you need.

The LM3909 is a cheap, versatile IC. The circuit will produce a 1-kilohertz square wave with a peak-to-peak voltage equal to about 80% of the battery voltage. It will also work off a single 1.5-volt battery. Just about the only restriction here is that the circuit output should always see at least a 10K load. If that's a problem, you can do it with a single resistor.

The trimmer in the circuit adjusts the duty cycle of the square wave output. Shifting the duty cycle will change the sound of the tone. This will let two additional circuits produce uniquely different sounds and that will let you trace more than one pair of wires at a time.

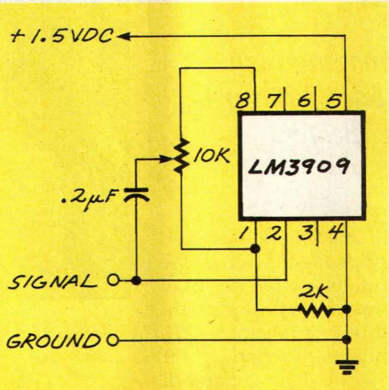

FIG. 1—THIS CABLE TRACER is inexpensive and the batteries last a long time.

This circuit is right from National Semiconductor's data book. It is so simple that you can put several of them in a single enclosure and have each produce a different frequency. While you could power all of them from a single battery, you might want to have a separate battery for each circuit. There's always a chance of having some signal leakage and crosstalk through the power supply and, even though critical audio isn't a concern with your job, it's so easy to avoid that you might as well do it anyway. Having separate batteries also means that they will last longer. It isn't often that a cheap alternative will work just as well as an expensive gadget. But when one does, it pays to take advantage.

ROBOT CONTROLLER

I recently bought an 8085 microprocessor trainer to build a controller for a robot. I don't understand the instruction set and haven't been able to program the microprocessor. I could build the controller with discreet logic but it wouldn't be as versatile. Do you have any ideas as to what I should do?—D. Vitez, Clinton, PA.

The old saying, "If you can't do the time, don't do the crime" pretty much sums up the problem you have at the moment. There's no point in playing with microprocessor hardware unless you also make a commitment to the Great Software God as well—one is pretty much useless without the other.

The 8085 instruction set isn't all that complex, and it's fairly representative of microprocessor instruction sets in general. If you're having a hard time with this one, chances are you'll have a hard time with any of them. You might be having a hard time because the trainer programming environment isn't user friendly. It's a lot easier to develop software on a real computer than on a trainer.

Some microprocessors (such as the old 8052) have a BASIC interpreter built-in so software can be written in a dialect of BASIC. This makes it easier to write software because computer languages don't come much simpler than BASIC. 8052 BASIC (and newer versions) contains the usual BASIC commands plus special features for control applications.

Single board computers are also available that provide a programming environment similar to the one on a desktop. Software can be developed on a desktop computer and either downloaded into the single board RAM or burnt into an EPROM for testing. The secret to writing software is having some way to debug it—and 640K of RAM in a desktop PC is a good place to do that.

If you're locked into the idea of using a microprocessor to control your robot—which is the best way to go—there's no way to get around the software. Contact some microprocessor manufacturers (such as Intel and Motorola) and find out what chips are best suited for your application. A microprocessor designed specifically for control applications is going to be easier to use than one that's not.

Continued on page 12

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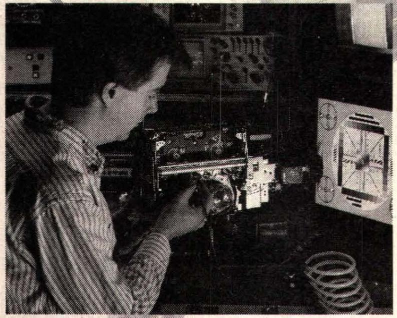

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The Mobile Electronic Certification Program (MECP) is the only industry-wide, nationally recognized testing program available for installers of 12-volt battery-powered electronics equipment. The program is intended to improve the quality of installations of those products which leads to a decrease in product returns and an increase in customer confidence.

The MECP will be administering tests at various locations across the country in the first three months of 1995. In January they will be given in Indianapolis (January 5), Las Vegas (during the Winter Consumer Electronics Show, January 8), Denver (January 12), San Diego (January 19), and New Orleans (January 26).

The tests will be held in Dallas/Fort Worth on February 2, Fresno on February 9, St. Louis on February 16, and Pittsburgh on February 23. In March, tests will be administered in Omaha (March 2), White Plains, NY (March 9), Minneapolis (March 16), and Madison, WI (March 23).

Registration deadlines are two weeks before the test dates. For more information on test locations, study guides, and cost, contact:

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TRANSFORMER TEST

I just received the November, 1994, issue of *Electronics Now*. As usual, I found most of the material quite interesting, especially "The TextGrabber," "The Frequency Doubler," the Tesla coil article, and "All About Phase-Locked Loops." However, I have five comments on "Simple Test for Transformers:"

First, the value of the transformer secondary voltage was given as 6.8 volts—twice in the text and once on the circuit diagram. The standard voltage for transformers is 6.3 volts and multiples of that value (e.g., 12.6 and 25.2). The 6.8 value is a standard for resistor ohms.

Second, 6.3-volt transformers might be hard to find (Mouser Electronics lists several). Any transformer voltage near 6 volts can be used (I found a 5.6-volt unit that worked). By contrast, 12.6-volt center-tapped transformers are available widely; connect one wire to the center tap and the second wire to the end terminal.

Third, a shorted transformer, connected as shown, will overload the transformer in the tester. I think a resistor should be connected between the top terminal of the 6.3-volt secondary and the top terminal of the AC voltmeter. That would also give a larger voltage drop if there were a shorted turn on the transformer under test. However, there would be a very small drop across the resistor if the transformer is good.

I would choose the resistor that would limit the current to the transformer's current rating. For a 6.3-volt, 1-ampere transformer, it would be a 6.2- or 6.8-ohm, 10-watt resistor; for a 6.3-volt, 0.2-ampere transformer, it would be a 33-ohm, 2-watt resistor.

Fourth, there is a possible safety hazard in the project. If another 6.3-volt transformer is being tested, and the secondary winding is connected to the test circuit, nearly 120 volts would appear on the unconnected primary leads of the transformer under tested, if it is a good unit. To avoid this hazard, first measure the resistance of the windings of the suspect transformer with an ohmmeter, and then connect only the winding with the highest resistance to the test circuit.

Fifth, many of the items pictured in the photograph accompanying the article cannot be tested with this circuit. In the last paragraph of the article, the word "chokes" should have been "iron-core chokes and larger ferrite-core chokes and coils." At 60 Hz, the reactance of a 100-MHz coil is about 36 ohms, and many of the coils in the photo look much smaller than those suitable for 100-MHz operation. If the test frequency were higher, smaller coils could be tested.

As a result of reading this article, I now have some ideas for a simple circuit operating at 2000 to 3000 Hz with an audible as well as a metered output. I plan to get to work on this project soon.

BILL STILES, CET
Hillsboro, MO

MORE ON TRANSFORMERS

I have been reading *Radio Electronics* and *Electronics Now* since the 1970's, and I have enjoyed learning and gaining ideas from your magazine—especially from authors like Don Lancaster. The magazine seems to have a good balance between simple and complex articles and projects. I believe that many newcomers to electronics can learn from the simpler articles—if the technical information in them is accurate and complete.

That is not the case with "A Simple Test for Transformers" (*Electronics Now*, November 1994). The article did not point out some shortcomings and hazards that are involved in the test method presented.

The inductive reactance of a coil winding depends on the number of turns and the core material. For example, an air-core winding would not have sufficient reactance at 60 Hz for the test to be valid. A good coil would appear as a short circuit, and its windings, which would only represent a low resistance, could burn out if high current were applied. The test method in the article is suitable only for low-frequency, iron-core transformers.

I measured the short-circuit output current of a 6.3-volt, 600-milliampere transformer. I obtained a reading in excess of 2.5 amperes.

If a 10-kilohm, 2-watt, flameproof resistor is wired in series with the primary winding of the 6.3-volt transformer, the secondary short-circuit current is reduced to a safe value of less than 200 milliamperes.

It is important to point out that when testing a step-down transformer's secondary winding, an unexpected high voltage—which would constitute a shock hazard—can appear on the primary winding.

ROBERT J. JOHANSEN
Staten Island, NY

QUESTIONING CSICOP

The Committee for the Scientific Investigation of Claims of the Paranormal, or CSICOP (recently praised by Don Lancaster and Larry Klein), does precious little scientific investigation and a lot of debunking and smearing of claims of the paranormal. The committee has three main operating principles:

1. Condemnation before investigation. The committee will not seek to verify claims of UFO experiences, success with dowsing, out-of-body experiences, or sightings of spirits. It denounces claims presented to them. Judging from its written opinions, the committee is adamantly opposed to anything that cannot be explained by existing physical science.

2. The committee picks on the weak, absurd, and vulnerable reports of the paranormal, and exposes and ridicules them (as they should). But it implies that there are no reports worth investigating (which is untrue).

3. Evidence must be physical. Thousands of people have testified to the reality of myriad paranormal phenomena—it has generally been non-conflicting testimony that would be accepted in a court of law. Yet the CSICOP calls such testimony anecdotal, not repeatable, hallucination or, worse yet, fraud.

It is just such narrow-minded people that now make up CSIOP (professors, intellectuals, and scientists) who have cried "impossible" and tried to prevent the introduction of any fundamentally new ideas in the fields of politics, religion, medicine, and science.

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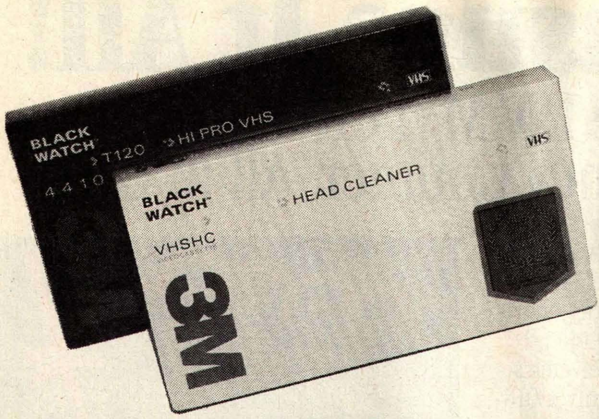

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Q&A

continued from page 8

LONG CABLE RUNS

My office has a small network installed and we recently took some more space on the floor below us. I want to put the computers in the new office on the network but the Novell manuals specify a maximum of 250 feet of cable on either side of the file server. Is there some simple way to get beyond this limit? I have to go almost twice this distance to reach the new office.—G. Nightingale, Bamford, NY.

The best around this problem depends on who gives the advice. Network people will start talking about a WAN (wide area network), hardware people will start talking about transceivers or short-haul modems, and everybody will talk about spending a lot of money.

It's true that networks work best when cable length limitations are observed and transceivers are installed when you must exceed standard distances. However, the maximum possible cable length without any degradation in network performance is also a function of the cable and connectors.

Network cable comes in different grades, and the cable quality will drastically affect the maximum safe lengths you can have. Better quality cable costs a bit more per foot but it's less expensive and much less of a hassle than adding additional hardware to the network.

Use double shielded cable to get beyond the standard Novell length limitation. This type of cable has a standard braided shield under the outer insulation and it also has the center conductor's insulation wrapped in foil. This extra shielding really cuts down on noise and signal loss on the network. I've run this cable over 700 feet from a file server without any loss in performance.

Double shielded cable is a pain in the neck to use because it's difficult to remove the foil when installing connectors, but it's an easy solution to your problem. Be sure to use good quality connectors, or you'll defeat the purpose of buying expensive cable. Ω

EQUIPMENT REPORTS

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CIRCLE 15 ON FREE INFORMATION CARD

An oscilloscope is probably the most useful test instrument that an electronics technician can have. When the capabilities of a digital multimeter (DMM) are exhausted, an oscilloscope takes over. A DMM can indicate the presence of an AC or DC voltage, but it doesn't allow the user to visualize the signal. An oscilloscope is necessary for determining such things as the presence of an audio signal or whether the signal is being amplified. Troubleshooting digital circuitry also requires an oscilloscope to determine if digital data is present where it should be and if it is correct.

Although oscilloscope prices have declined dramatically over the last decade, cost still restricts many oscilloscope purchases. A new, basic oscilloscope will cost about $300, although at that price, it will lack many desirable features. The most inexpensive full-featured oscilloscope will cost upwards of $500, and high-performance instruments with digital storage are priced over $1000.

Every electronics enthusiast should really have an oscilloscope on his test bench, but the price of a versatile high-perfomance instrument is often too high for the average hobbyist—even many professional service centers need ultra-low-cost instrumentation for some of their repair stations.

An alternative

It's a safe bet that more *Electronics Now* readers own personal computers than personal oscilloscopes. A PC contains a CRT in its monitor, and its sophisticated circuitry can be programmed to do countless tasks under software control. What happens if a test signal is presented to an input port on a PC? With the right software, the computer can display the signal just like an oscilloscope!

That's just what the Allison Technology *O-Scope I* does—it's a low-cost, single-channel, digital storage oscilloscope module for an IBM PC-AT (or better) compatible computer. (XT-compatibles are too slow to be used successfully with the scope module.) The module connects to a PC's printer port and converts the computer into a single-channel digital storage oscilloscope. (Allison Technology Corp., 8343 Carvel, Houston, TX 77036, 713-777-0401.)

The O-Scope I can display input signals from DC to 22 kilohertz, and freeze the display at any time. The plot can then be printed or saved to disk for later use or for inclusion in other programs. Vertical resolution ranges from 10 volts per division down to 50 millivolts per division. Sweep rates from 100 seconds per division to 500 microseconds per division can be selected. Digital signal processing allows the sweep to be expanded from ×2 to ×16.

The O-Scope I also numerically displays voltage, frequency and period measurements in an on-screen table. The voltages include peak-to-peak, average, peak, minimum, and RMS. In addition, a 128-point Fourier spectrum analyzer mode permits the display of frequency-spectrum information from DC to one half of the set sampling rate.

A single-channel, 22-kilohertz oscilloscope is not the most versatile of instruments, but for the amateur electronics enthusiast, O-Scope I's bang for the buck can't be beat. The unit sells for $169.95 fully assembled in a shielded plastic case, and for $119.95 as a kit without the case, which is available separately. The unit has enough practical uses that many hobbyists—and many professionals who need an extra oscilloscope—might want to take advantage of the deal.

Operation

O-Scope I is connected to the PC's printer port with the supplied ribbon-cable. The default port is LPT1, but other port addresses can be specified when the program is started. A test program is included for users who are unsure of the address of their computer's printer port. An AC adapter that plugs into the scope module and provides the necessary 12-volts DC oscilloscope operation is supplied.

A standard ×1 or ×10 oscilloscope probe (not included) connects to a BNC connector on the module. A probe is not included with either the assembled O-Scope I or the kit. The program runs in DOS only, and is started by typing "OS-

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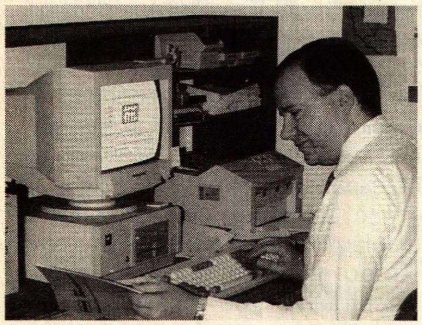

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COPE" at the DOS prompt, followed by a port address if other than LPT1 is used.

The cursor keys control most of the oscilloscope functions. The up and down cursors move a function indicator to different menu selections, and a selection is changed with the left and right cursors. Other commands are activated by keystrokes. The A key selects AC coupling; C toggles connecting lines between samples; D selects DC coupling; F toggles between sweep and spectrum; X toggles between ×1, ×2, and ×5 sweep expansion; the Space bar freezes the display until the next keystroke; P cycles through special DSP processing to expand the sweep by ×2, ×4, ×8, and ×16; L toggles the log-to-disk option; and Escape terminates the program and returns to DOS.

To use O-Scope I, both it and the PC must be powered up before the two are connected together. O-Scope I should also be powered and connected to a PC before the probe is connected to an external circuit.

O-Scope I has an input impedance of one megohm, and a maximum input voltage of ± 60-volts DC or 40-volts AC. It is accurate to within 3 to 4%. Although the scope's input is fuse-protected, excessive voltages can damage both the module and the computer, so it might be better to use an older computer with the scope module and reserve your new 486- or Pentium-based machine for more conventional applications. The performance of O-Scope I will not be enhanced by a powerful computer.

All in all, the O-Scope I should be especially easy for anyone familiar with both PCs and oscilloscopes, and easy to learn for anyone unfamiliar with either or both.

Even though the $169.95 fully assembled O-Scope I is a practical investment for an electronics hobbyist, avid kit builders might want to take advantage of the extra savings ($50) offered by purchasing the kit version. Building the kit is not complex; there is enough work to keep a builder busy for about an evening. A DMM is the only instrument needed for checking voltages and continuity. Calibration calls for adjusting only a single potentiometer that roughly centers the 0-volt DC level on the display.

Anyone who wants to do professional-level testing will probably need more than the O-Scope I offers. But for hobbyists and others who are still learning electronics—and might be saving their money for a high-performance scope—O-Scope I offers a lot. Ω

WHAT'S NEWS

continued from page 4

Electronics Industry Hall of Fame inductees

Three technicians/service dealers were inducted into the Electronics Technicians Division of the Electronics Industry Hall of Fame on August 13, 1994. George Bluze CET/CSM of Largo, FL, Robert Villont CET/CSM of Tacoma, WA, and Don Winchel CET of Smartville, CA, were inducted at the National Professional Electronics Convention held in Portland, OR.

Bluze served as president of the National Electronics Service Dealers Association (NESDA) and president of NESDA-Florida. He has been a test administrator for the International Society of Certified Electronics Technicians (ISCET) since 1979. Bluze has also been NESDA Man of the Year, Officer of the Year, and Outstanding State President, and he was ISCET Technician of the Year in 1982.

Villont was NESDA president during the association's move from Indianapolis to Fort Worth and was the NESDA Region 10 director for several years. He was NESDA's representative to the ISCET Board of Governors for 13 years from 1980 to 1993 and he has also been NESDA's Man of the Year Award.

Winchel was a board member for both NESDA and ISCET for more than 11 years. He served two terms each as chairman of ISCET and was president of the California State Electronics Association. An ISCET test administrator for many years, he made the ISCET Serviceability program prominent nationally.

Official nomination forms for the Hall of Fame are available from the Electronics Industry Hall of Fame, Inc., 500-B Bi-County Blvd., Farmingdale, NY 11735. Ω

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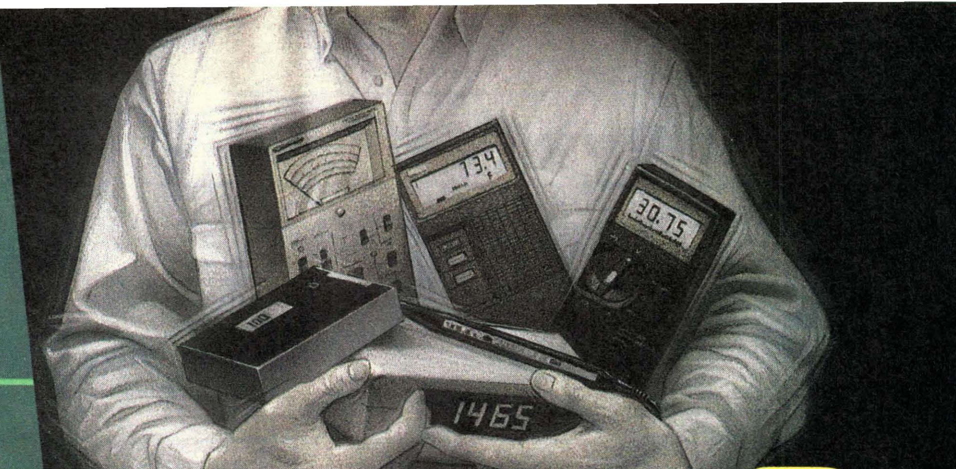

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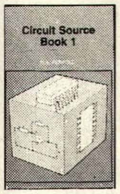

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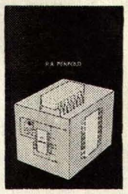

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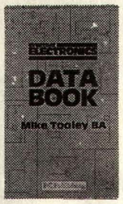

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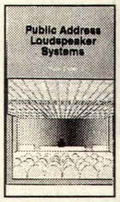

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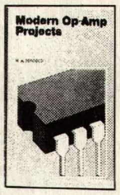
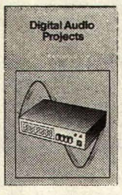
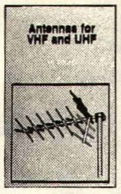


☐ **BP106—Modern OpAmp Projects... $5.75.** Various projects that make use of operational amplifiers available to hobbyists. Text includes low-noise, low-distortion, ultra-high input impedance, low slew-rate and high current types.



☐ **BP245—Digital Audio Projects...$5.95.** Practical details of how to construct a number of practical projects. All should be of interest to most audio and electronic music enthusiasts. Some of the projects are: oscilloscope storage circuit, A/D converter, negative supply, input amplifier, low-noise microphone preamp, compressor and expander circuits, input mixer, echo effect circuit, and others.



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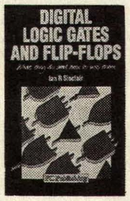
☐ **PCP105—Make Money from Home Recording...$10.00.** Start earning money after you spent a "fortune" on all that professional recording gear, MIDI and all. Here's the book that tells you how! Whether you have a fully fledged recording studio at home, or just a couple of stereo cassette recorders and a microphone, you'll be able to put the ideas presented in this book into immediate practice and make money.



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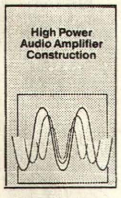
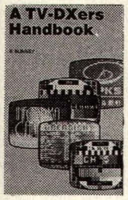


☐ **BP277—High Power Audio Amplifier Construction...$6.25.** Practical construction details of how to build a number of useful audio power amplifiers ranging from about 50 to 400 watts rms. Text includes MOSFET and bipolar transistor designs.



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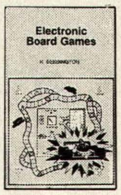

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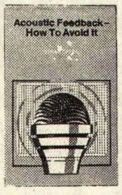

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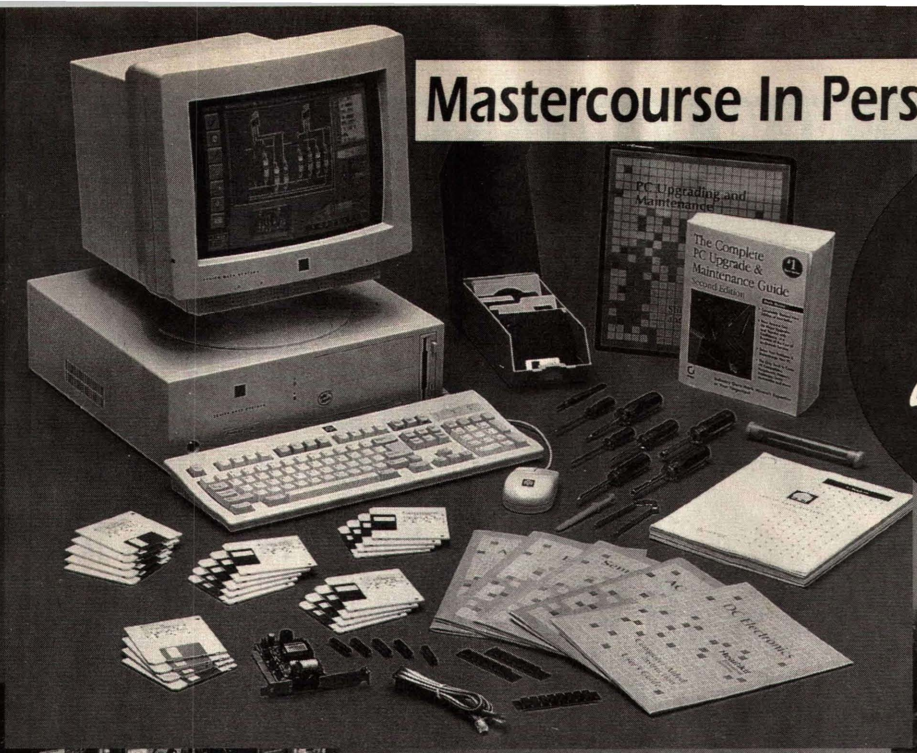

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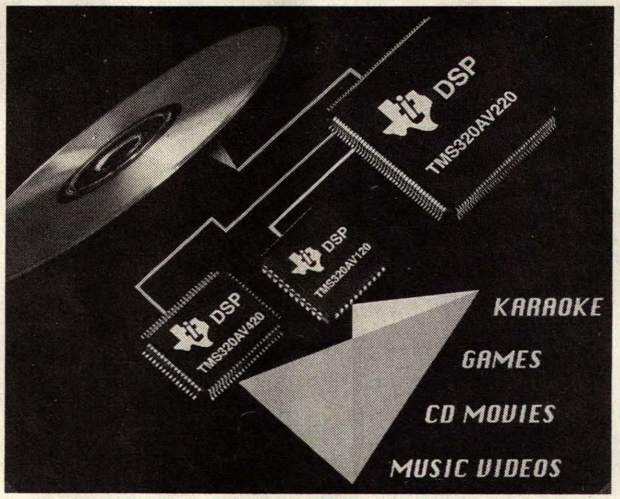
VIDEO COMPUTER DISC CHIP SET. Texas Instruments has introduced the industry's first video CD chipset that is expected to simplify the design of Moving Picture Experts Group-1 (MPEG-1) video and audio decompression subsystems. The chip set decodes, synchronizes, and decompresses audio/video data that has been encoded to the MPEG international compression standard.



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Capable of introducing a full-motion video (FMV) subsystem to home-entertainment products such as CD-based movie players, video games, and karaoke systems, the set consists of the TMS320AV220 MPEG-1 video decoder, the TMS320AV120 MPEG audio decoder, and the TMS320AV420 National Television Standards Committee (NTSC) encoder.

Those three devices, installed with a 4-megabit DRAM and a digital-to-analog converter for the converting the audio output, will turn a CD player into a video CD player. The set produces a video signal encoded in the NTSC format for broadcast TV and an audio signal that can be played back either over TV or through a stereo system for CD-quality digital sound.

The audio encoder is packaged in either a 44-pin plastic leaded-chip carrier (PLCC) or an 80-pin quad flatpack (QFP). The video decoder is packaged in a 160-pin QFP, and the NTSC encoder is packaged in an 80-pin QFP.

The high-volume pricing for the complete set is under $40.

Texas Instruments Incorporated
Literature Response Center
SC-94035
P. O. Box 172228
Denver, CO 80217
Phone: 1-800-477-8924, ext. 4500

SMT/THRU-HOLE REPAIR CENTER. The SMD-250 surface-mount and leaded component repair and rework station from A.P.E. is a set of tools for removing and replacing surface-mount and leaded components by hot-air or thermal methods. It can perform conventional thru-hole desoldering and both reflow and conventional soldering. It also includes vacuum parts handling and solder-paste dispensing capability.

CIRCLE 21 ON FREE INFORMATION CARD

The repair system has two programmable digital controllers under closed-loop temperature control. The tool tip can be set at any temperature from 350 to 875°F without changing either the tip or the heater element. Temperatures are displayed on a three-digit LED readout.

The SMD-250 includes a fast-response, rotary-vane vacuum pump that provides a vacuum at 23 inches of mercury in 150 milliseconds which can withdraw molten solder in 30 milliseconds. A variable-pressure output control adjusts hot-air flow for surface-mount component solder reflow. Zero-voltage thyristor switching protects voltage- and current-sensitive devices against transient voltage spikes.

Both the 120- and 240-volt SMD-250 models are priced at $1995.

Automated Production Equipment Corp. (A.P.E.)
142 Peconic Avenue
Medford, NY 11763-3201
Phone: 516-654-1197
Fax: 516-289-4735

PORTABLE SCOPE-PLUS-METER. Fluke Corporation has introduced the latest of its ScopeMeter test instruments, the Series II. It combines a dual-channel, 50-MHz digital storage oscilloscope and a 3⅔ true-RMS multimeter in one battery-powered, handheld unit.

The new models have additional measurement functions including a "measure menu" that automatically configures the instrument for any of 30 measurement tasks and a "continuous autoset," function that eliminates the need for manual front-panel adjustments when the probe is moved from one test point to another. The instrument can be switched back to conventional operation at any time.

Series II ScopeMeters offer a "windowing" menu structure that gives quick access to any function with a few keystrokes. Moreover, a Series II in meter mode continuously displays waveforms simultaneously with measurement values. It is not necessary to switch to oscilloscope mode to see a signal waveform view of a signal unless

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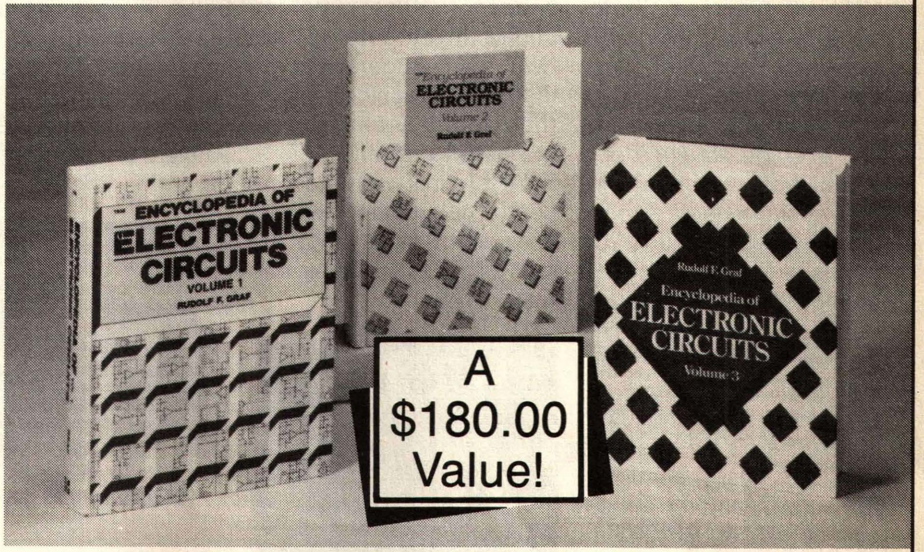
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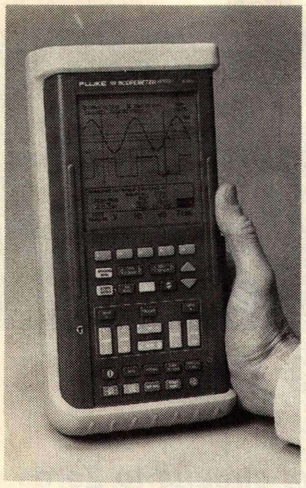

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greater waveform detail is needed.

Two "min/max" functions have been included: A min/max TrendPlot function simultaneously graphs the minimum, maximum, and average readings of a signal between two minutes and 30 days; A min/max envelope function gives a record of all changes to the displayed oscilloscope waveform, displaying all the minimum and maximum values on the screen simultaneously.

Four Series II models are available: dual-channel 99, 96, and 92, and the single-channel 91. An RS-232 interface permits the printout of data from the 96 and 99 (shown here). Optional FlukeView software for DOS- or Windows-based PCs is available for the Model 99.

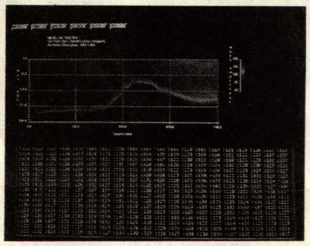
Model 99 includes a signal generator for producing sinewave, squarewave, and component test signals.It also performs waveform calculations. The Model 99 can store 10 screens, 20 waveforms, and 40 instrument setups. The Model 96 can store five screens, 10 waveforms, and 20 front-panel setups.

The price of the Model 99 is $2195, the 96 is $1895, the 92 is $1595, and the 91 is $1295.

Fluke Corporation
P. O. Box 9090
Everett, WA 98206
Phone: 800-44-FLUKE
Fax: 206-356-5116

DATA DEBUGGING TOOLSET. Data Debugging Toolset (DDT) software from CST Images will assist in debugging complex data-manipulation software. It is said to fill the gap between standard source-code debuggers and generic graphic toolsets.

DDT provides non-graphic, logic-based debugging controls to be embedded in a user program under development. The DDT routines generate remote X11 graphic displays that permit viewing program data results on a SPARC Unix workstation, control debugging flow, and analyze massive data arrays into a clear graphic format.



CIRCLE 23 ON FREE INFORMATION CARD

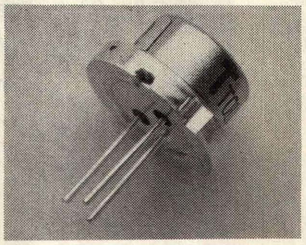
The program was developed as a quick analysis tool for general data processing, signal processing, data acquisition, and other scientific and engineering data processing. DDT allows the developer to insert debug routine calls into C and FORTRAN code at key points where the data can be viewed or checked for complete algorithm verification.

One program call generates one graph. The controls allow the program results to be stepped or viewed after a number of computations without intervention. DDT is available for SPARC/Solaris computers, Motorola 167 processors, and various CSPI Supercards.

DDT has a price of $499 per library.

CST Images
5055 Viewridge Ave. B
San Diego, CA 92123
Phone: 619-277-7833
Fax: 619-576-9859

RED-LIGHT VISIBLE LASER DIODE. The TOLD9521 red-light-emitting visible laser diode (VLD) from Toshiba America, draws 75 milliamperes while emitting at a wavelength of 635 nanometers. It produces 3 milliwatts of output power when operated in the rated ambient temperature range of −10°C to 50°C.



CIRCLE 24 ON FREE INFORMATION CARD

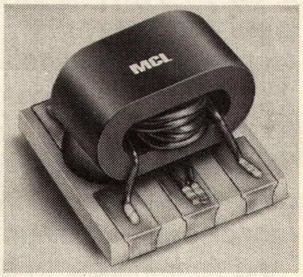
The TOLD9521 is seven times brighter than Toshiba's 670-nanometer VLD. Its brighter beam can be seen more easily by the human eye at safe power levels. The TOLD9521 is intended as a light source in instruments for leveling and aligning ceilings, bar-code scanners, laser printers, and communications systems.

Visible red-light emitting diodes are smaller, have lower power requirements, and higher efficiency than helium neon (HeNe) gas lasers that emit in the same visible region. They also have a higher response to input currents. Toshiba's visible laser diodes are made from crystals containing indium, gallium, aluminum, and phosphorous (InGaAlP).

TOLD9521 red-light-emitting VLDs are priced at $100 each.

Toshiba America Electronic Components, Inc.
9775 Toledo Way
Irvine, CA 92718
Phone: 714-455-2000

MINIATURE SURFACE-MOUNT TRANSFORMER. The miniature TC4-1W RF transformer from Mini-Circuits has a bandwidth of 3 to 800 MHz and features DC isolation between its primary to secondary windings. Recommended for impedance matching and land-mobile radio, it measures only 0.16 × 0.16 × 0.16 inch.



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The surface-mountable transformer was designed for circuit-board placement with pick-and-place machines. The transformers are available taped on reels for placement with those machines.

The TC4-1W transformer is priced at $4.95 each.

Mini-Circuits
P. O. Box 350166
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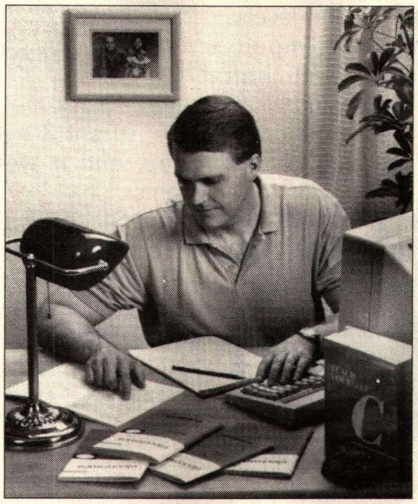

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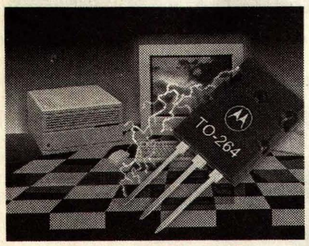

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power MOSFETs from Motorola is intended for high-power applications. The MOSFETs can safely dissipate 300 watts internally and control loads up to 5 kilowatts.

The TO-264 package (formerly known as the TO-3PBL), includes a large silicon die that measures 315 × 470 mils. A single TO-264 MOSFET can eliminate the need for paralleling multiple TO-247 power MOSFETs to handle higher current and achieve lower ON-resistance.

The TO-264 package is about 50% larger than the TO-247 package, but its pin spacing is identical making retrofit relatively simple. The TO-264 family includes 500-, 600-, and 1000-volt MOSFETs.

The prices for TO-264 MOSFETs range from $5.45 to $11.10 each in high-volume purchases.

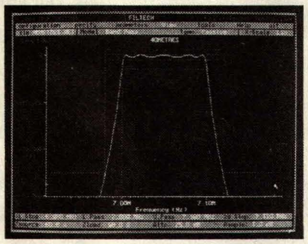
Motorola, Inc.
MD Z311
5005 East McDowell Road
Phoenix, AZ 85018
Phone: 602-244-3071
Fax: 302-244-3015

FILTER DESIGN PROGRAM. The Filtech filter design program from Number One Systems is an aid for designers of active and passive filters. It can synthesize both active and passive filters up to sixth order with a frequency range extending from fractions of a hertz to more than a gigahertz.

Filtech can independently analyze the synthesized filter circuits and display a graphic plot of the calculated frequency response superimposed on the specified filter limits. This feature quickly confirms the accuracy of the synthesis design process.

The designer need only key in passband and stopband frequency limits, ripple and attenuation levels, and terminating impedances. Filtech will then complete the design.

Filtech software complete with a manual containing sample designs and a tutorial on filters is priced at $275.



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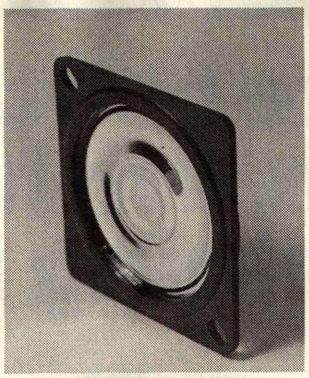
Number One Systems
1795 Granger Avenue
Los Altos, CA 94924
Phone/Fax: 415-968-9306

PLASTIC FRAME SPEAKER. A miniature, square, "pancake" Model S150SLA speaker from the Intervox div. of ICC has an ABS plastic frame, a polyester cone, and a rare-earth magnet. It was designed as an audible signal source for modems and laptop or other small portable computers that have internal space restrictions.

The S150SLA speaker has a nominal voice-coil impedance of 8 ohms, a normal power rating of 200 milliwatts, and an output sound pressure level (SPL) of 81 dB measured at one meter. Its resonant frequency is 550 Hz. The speaker's front face measures 40 millimeters on a side, it is 4.3 millimeters deep, and it weighs 5.8 grams.



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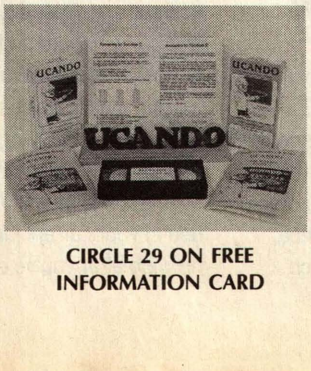
The S150SLA speaker is priced at $1.59 in high-volume purchases.

International Components Corporation
105 Maxess Road
Melville, NY 11747
Phone: 516-293-1500

EDUCATIONAL VIDEOS. Three new educational videos from Ucando VCR Educational Products depend on computer animation to show viewers how electronic devices and circuits works. Each video has a playing time of one hour.

Understanding Fiber Optics is a step-by-step introduction to the basics of fiberoptic technology. It illustrates and explains fiberoptic cables, connectors, couplers, splicing techniques, transmitters, and receivers.

FM Radio: Parts 1 and 2 teaches the fundamentals of frequency modulation. The video covers the new RDS/RDBS methods for digital data encoding and decoding.



CIRCLE 29 ON FREE INFORMATION CARD

Ucando videos are priced at $44.95 each.

Ucando VCR Educational Products Company
P. O. Box 928
Greenville, OH 45331
Phone: 800-678-6113
Fax: 513-548-6124

PCMCIA DIAGNOSTICS CARD. The BGM64 PCMCIA diagnostic card from Boca Technology Group is a universal PCMCIA interface diagnostic tool. The card can be plugged into a PCMCIA-compatible slot on a computer or peripheral to permit the diagnosis of manufacturing faults. It can also serve as a PCMCIA product hardware and software development tool.

PCMCIA
DIAGNOSTIC
CARD
Boca Technology Group, Inc.

CIRCLE 30 ON FREE INFORMATION CARD

The installed diagnostic software allows the BGM64 to test all 16 bits of data on an emulated 64 megabit address space. Reads and writes throughout the address space are possible. The BMG64 can detect manufacturing defects, such as open and short circuits on the data and address bus. Failures in status signals and inadequate power supplies can be screened before the product is shipped.

The BGM64 PCMCIA diagnostic card is priced at $249.

Boca Technology Group
21346 Saint Andrews Blvd., Suite 219
Boca Raton, FL 33433
Phone: 407-750-1528
Fax: 407-750-8873 Ω

NEW LITERATURE

Use The Free Information Card for fast response.

Pleated-Foil-Covered I/O Cable Assemblies. 3M Electronic Products Division; 6801 River Place Blvd., Austin, TX 78726-9000; Phone: 800-225-5373; free.

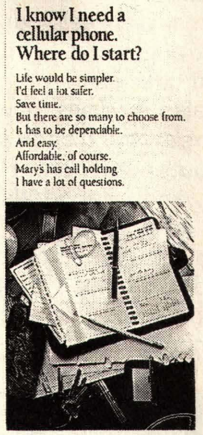
This four-page, color brochure describes 3M's new, pleated foil-covered input/output cable for computer data transmission, communications, and instrumentation data transfer. The cable assembly includes the 3M miniature delta ribbon (MDR) connector and pleated-foil cable (PFC). Its durable construction is said to offer high signal density, excellent electrical performance, and EMI shielding.

3M
Pleated Foil Covered
I/O Cable Assemblies
High Density,
High Performance

CIRCLE 337 ON FREE INFORMATION CARD

The brochure includes a cross-section illustration of the MDR/PFC assembly, a chart outlining the cable assembly's electrical properties, color illustrations, and complete cable ordering information.

I Need a Cellular Phone ... But Where Do I Start? Motorola Cellular Information Center; Phone: 800-331-6456, extension 2504; free.


I know I need a
cellular phone.
Where do I start?

Life would be simpler.
I'd feel a lot safer.
Save time.
But there are so many to choose from.
It has to be dependable.
And easy.
Affordable, of course.
Mary's has call holding
I have a lot of questions.

CIRCLE 338 ON FREE INFORMATION CARD

A cellular phone is a valuable time-saving convenience for anyone who must travel extensively and yet stay in touch with a home office or operations base, customers, clients, or prospects. But buying a phone, subscribing to a cellular telephone company, and selecting a service plan can be daunting even for sophisticated people.

Motorola's brochure lists tips to keep in mind when buying a cellular phone. It explains the different categories of cellular phones. Mobile phones, which are permanently installed in a vehicle, consume three watts of power and are ideal for those people who must spend a lot of time in their cars.

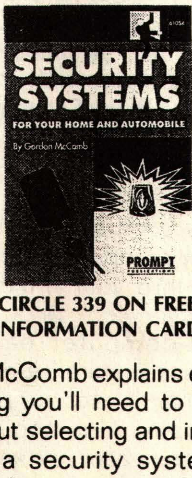
Transportable phones have self-contained batteries so they can be moved from one vehicle to another. They are a better choice for those who are likely to drive several different cars each day or must spend a lot of time away from their cars.

Portable, lightweight, handheld phones, can be carried in a purse or briefcase. They are recommended for those who are continually on the move, who switch from private to public transportation, or who must walk around a lot during the day.

The brochure outlines the six key points to investigate when buying a cellular telephone: talk time, sound quality, range, comfort, special features, and price. A glossary of cellular phone terms is also included.

Security Systems for Your Home and Automobile; by Gordon McComb. Prompt Publications, 2647 Waterfront Parkway, East Drive, Indianapolis, IN 46214-2012; Phone: 800-428-7267 or 317-298-5710; Fax: 317-298-5604; $16.95.

This book explains how to save money by installing your own security system. Modern security systems can deter property theft, vandalism, property boundary violations, and unwanted home intrusion. They even warn of fire and smoke danger.



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McComb explains everything you'll need to know about selecting and installing a security system in your home or car with readily available tools. The book describes the basics of home and automotive security systems, and explains how to determine which system is right for your needs.

System components, including controllers, sensors, and warning alarms are explained. The book also discusses self-contained home and automotive security systems.

Looking Good with CorelDRAW! Third Edition; by Sheldon Nemoy and C.J. Aiken. Ventana Press, P. O. Box 2468, Chapel Hill, NC 27515; Phone: 919-942-0220; Fax: 919-942-1140; $27.95.

This book explains how to get the most out of version 5 of CorelDRAW! This updated third edition contains hundreds of illustrations and step-by-step instructions for creating attractive graphics with CorelDRAW! 4 or 5.

A section of the book covers fundamental elements and program calls. It gives instructions for and examples of advanced techniques for constructing those elements. Icons on the screen indicate instructions that are specific to versions 4 or 5.

Nemoy and Aiken offer a wealth of practical advice for producing graphics including posters, book jack-

Looking Good CorelDRAW!
Hundreds of Tips, Techniques & Ideas for Creating Great Art on Your Computer

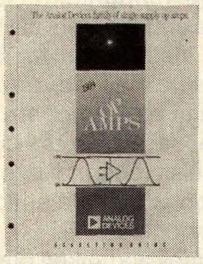
CIRCLE 340 ON FREE INFORMATION CARD

ets, newsletters, and brochures. Examples show how to include graphic effects like clouds, chrome, and glass in your drawings.

The authors also explain how to save time with the program's tabbed dialogs, accent art work, and perform color, shading or texture fills. You'll also learn how to make 3D extrusions with up to three light sources.

Op Amps Selection Guide. Analog Devices, Inc., 181 Ballardvale Street, Wilmington, MA 01887; Phone: 617-937-14228; Fax: 617-821-4273; free.

This six-page selection guide to Analog Devices' single-supply operational amplifiers includes key specifications and technical information on more than 30 products. The brochure simplifies the selection of single, dual and triple op-amps such as the low-power, precision, instrumentation, and low-noise models that operate from single 1- to 36-volt supplies.



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The guide also explains the available choice of industry-standard JEDEC op-amp packages that Analog Devices offers for various applications. Some products are available on tape in reels for surface-mount placement.

Literature Review. Eaton Corporation, Commercial Controls Division, 4201 North 27th Street, Milwaukee, WI 53216; Phone: 414-449-7483; free.

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Eaton's Literature Review identifies more than 55 catalogs that are available from Eaton's many divisions that manufacture products ranging from relays, sensors, switches, and transducers to other parts like actuators and circuit breakers.

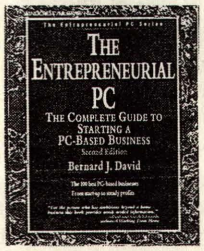
The four-color brochure details catalogs from divisions that include Arrow-Hart, Consolidated Controls, Control Displays, Cutler-Hammer, Heinemann, and MSC Products to simplify selecting the right one for the specific products you need.

The Entrepreneurial PC: The Complete Guide to Starting a PC-Based Business, Second Edition; by Bernard J. Davis. Windcrest/McGraw-Hill, Blue Ridge Summit, PA 17294-0850; Phone: 1-800-233-1128; Fax: 717-794-2103; $17.95.

This book explains how to turn your personal computer into your principal production tool for a personal-computer based business venture—It could be writing, accounting, consulting, desktop grapics preparation, or any of a number of other interesting possibilities.

The author discusses the requirements for success in any new venture, and explains how to evaluate your skills, goals and readiness to start your own business. You'll learn how to select the right business to match your expectations and skills, how to make a business plan, sell your services, and run your home-based business.

It also explains how to choose the necessary computer software, hardware, and peripherals for your new business. The book discusses finances, including the need for start-up money and where to get the money.


The Entrepreneurial PC Series
THE ENTREPRENEURIAL PC
THE COMPLETE GUIDE TO STARTING A PC-BASED BUSINESS
Second Edition
Bernard J. David

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Davis describes in detail many business possibilities and the requirements for entry into them. He balances his discussion by listing potential roadblocks, but he explains how to avoid them. A separate appendix lists and describes 75 more home-based business ventures that depend on the personal computer.

Build Your Own Home Theater; by Robert Wolenik. Sams Publishing, Div. of Prentice Hall Computer Publishing, 201 West 103 Street, Indianapolis, IN 46290; Phone: 317-581-3500. $16.95.

This book explains how to assemble a complete home theater from standard, off-the-shelf, audio and video components.

Wolenik describes the many options available for

Build Your Own HOME THEATER
SAMS

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building a home theater including stereo, broadcast and cable television, VCR, laserdisc player, satellite receiving antenna, surround-sound speakers, and camcorders.

The author goes into technical detail in explaining the differences between the many products in each of the entertainment product categories. For example, you'll learn what some of the important differences are between rear-projection, front-projection, and direct-view television receivers.

He also explains the importance of color, clarity, and resolution for pleasurable viewing, and the difference between Dolby Surround and Dolby Pro-Logic. You'll even learn how to place your speakers for the optimum surround-sound effect with encoded programming.

In addition to discussing the manufactured products, Wolenik includes guidance on the selection of the optimum room in your house or apartment for the installation of a home theater system.

He tells you how to install acoustic insulation in that room to minimize or eliminate unwanted noise to improve viewing and listening pleasure.

A 16-page, full color insert in the book illustrates actual home-theater installations, and pricing information is included for many of the components shown. Ω

COMPUTER CONNECTIONS

Don't interface—interact.

JEFF HOLTZMAN

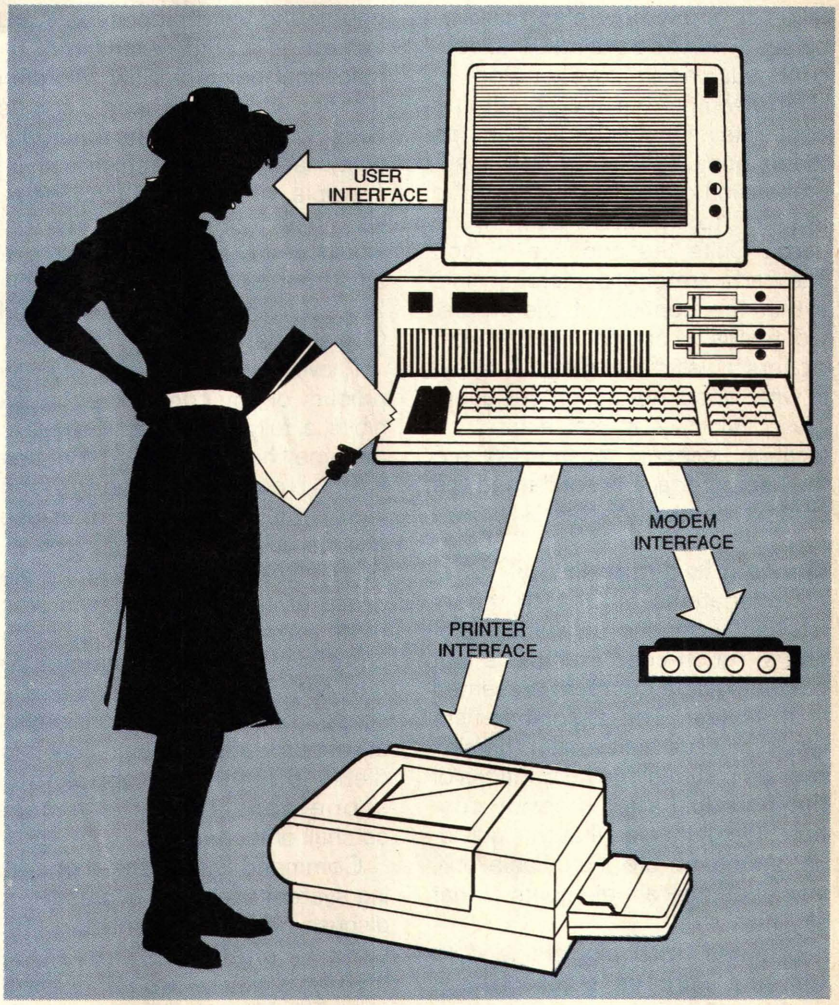
Last month I started a discussion of computer-industry unmentionables, beginning with the "D" word, documentation. Second on my list is the user-interface design. What is user-interface design?

Some think of it as sizing, shaping, and coloring screen widgets to achieve a visually pleasing result. That viewpoint is so outrageously incorrect as to be unworthy of comment. It comes from a prejudice based on an underlying "how" view of the world, versus a philosophic, theosophic, or even aesthetic "why" point of view.

Look at your computer (or at Fig. 1). It's got a serial interface, a parallel interface, a video interface, a hard-disk interface, a network interface, and a *user* interface. From one point of view (POV1), the user interface is just another thing that links the computer to some peripheral device, be it a printer, a modem, a network, or in this case, a user. That view might sound ridiculous, but that's how many computer and software designers view the situation.

It would be easy to adopt a contrary point of view (POV2) that says the user is primary, and the computer secondary. The computer is just another member of the class of things that we human beings use to extend our capabilities, much like the car, the telephone, the microscope, and the telescope. This is a tack frequently taken by social scientists, anthropologists, and cultural analysts.

A third point of view (POV3) avoids the reductionist simplifications offered by the first two. It doesn't seek understanding by reducing a complex situation to a set of interactions among simple elements. Rather, it views the situation as a whole, along with the interactions among the elements, as primary. User interface design thus becomes user interaction design.



USER INTERFACE DESIGN: Is the user just another peripheral with her own special interface? Is the computer an extension of human capabilities? Or is there something more to it?

Context

If you view the user interface as a conduit between the user and the computer, as do both POV1 and POV2, then you tend to focus on the characteristics of the conduit, the objects attached to either end of it, or the couplings between the conduit and the objects. From this mechanistic point of view, increasing bandwidth is seen as the primary means of increasing efficiency. In reality, this results in an ever-escalating desire for faster computers and higher resolution video screens—as well as smarter users. But suppose we had computers of infinite speed, and output devices of infinite resolution. Would computers be any easier to operate? In the absence of other changes, the answer is a resounding *No!*

POV3, or user interaction design, does not discount the need for greater computing power and resolution. But rather than putting the objects first, it views their interaction, their environment, and their *Gestalt* as primary.

Gestalt is a German word imported into English by turn-of-the-century psychologists who sought to surpass the mechanistic (Newtonian) notions prevalent in the dominant theory of the time, associationism. Associationism holds that perception is the summation of numerous acts of sensation. The problem was that the associationists failed to show how electrical impulses in nerves translated into concepts such as life, love, or God.

Borrowing from then-emerging concepts of field theory, Gestalt theory posited, in contrast, that apprehension of the whole cannot be reduced to the mere sum of the parts. Quite the opposite in fact: The parts are only comprehensible within the context of the whole. Context is what poor interface designers usually fail to grasp. Context is what good interaction designers grasp implicitly. In real estate, it's location, location, location. Where the user interface is concerned, it's context, context, context.

Context is dynamic

Explanations of Gestalt theory frequently depend on static metaphors. An oft-cited example is that of identifying a structure presented in a skyline. The associationists would have us believe that the skyline is the sum of the perceptions of the individual structures. By contrast, Gestalt holds that the individual structures are identifiable only insofar as they are elements of that skyline.

Likewise, technologists tend to view the world as a collection of function boxes: input, process, output. The user clicks a mouse button, the computer does some processing, then presents some new output. Input, process, output. User, computer, screen. By contrast, a Gestalt view would see one thing—the interaction process—as a dynamic context in which inputs, processing, and outputs occur.

There are thus two primary yet diametrically opposed points of view concerning human-computer interaction: functional and process-oriented. The functional view has prevailed throughout the entire history of computing; it is only in the last few years, with the rise of the field called usability engineering, that the process-oriented point of view has started to attract serious attention. In the commercial world, the shift is beginning to manifest itself with a shift away from the functional paradigm toward something else, for which there is, as yet, no fully developed example.

The DOS version of the number one selling word processor, WordPerfect, is a prime example of the functional point of view. WordPerfect has scores and scores of functions, which despite their individual utility, lack an overarching unifying principle, or Gestalt. With Gestalt, all those features and functions would come to have meaning, to stand out as clearly as the Empire State Building does in the New York City skyline.

I have no example of a software product of any complexity that exhibits a fully developed Gestalt of the type I have discussed. But here is how you might recognize one. First is the obviousness of its use, given a basic understanding of the overall Gestalt. Second is the elegance of its design, which in practical terms means discernible pattern in the way functions are grouped and presented. Third is scope consistency, or consistency at various levels of design (low, middle, and high). The opposite of scope consistency is a huge catchall of features.

Command-line oriented operating system shells are interesting to discuss from this perspective. The Unix C shell and the DOS COMMAND.COM are two prime examples. The Unix shell has an almost astounding collection of tools, which is great. What is bad is the total lack of consistency among them. Even among people who aren't afraid of command-line interfaces, Unix commands provide a severe test. It's not hard to stump even experienced Unix users on some arcane feature or another.

The MS-DOS shell can be viewed as a very limited subset of the Unix shell, but it is, nonetheless, full of inconsistencies. For example, modern versions of the DIR command allow you to select and sort directory listings in various ways. In a better system, the same select and sort options would apply to commands across the board. For example, the command `DIR /AD /S /B` lists all directories beneath the current directory. If the COPY command had the same options, I could duplicate the disk structure, without copying all the associated files, by typing `COPY FROMDISK TODISK /AD /S /B`.

In the graphical user interface (GUI) world, it is instructive to compare OS/2 to Windows 3.1 and to the upcoming version of Windows, code-named Chicago, but now officially known as Windows 95. There is nothing to be said that hasn't already been said about the problems with the Program Manager/File Manager dichotomy in Win31.

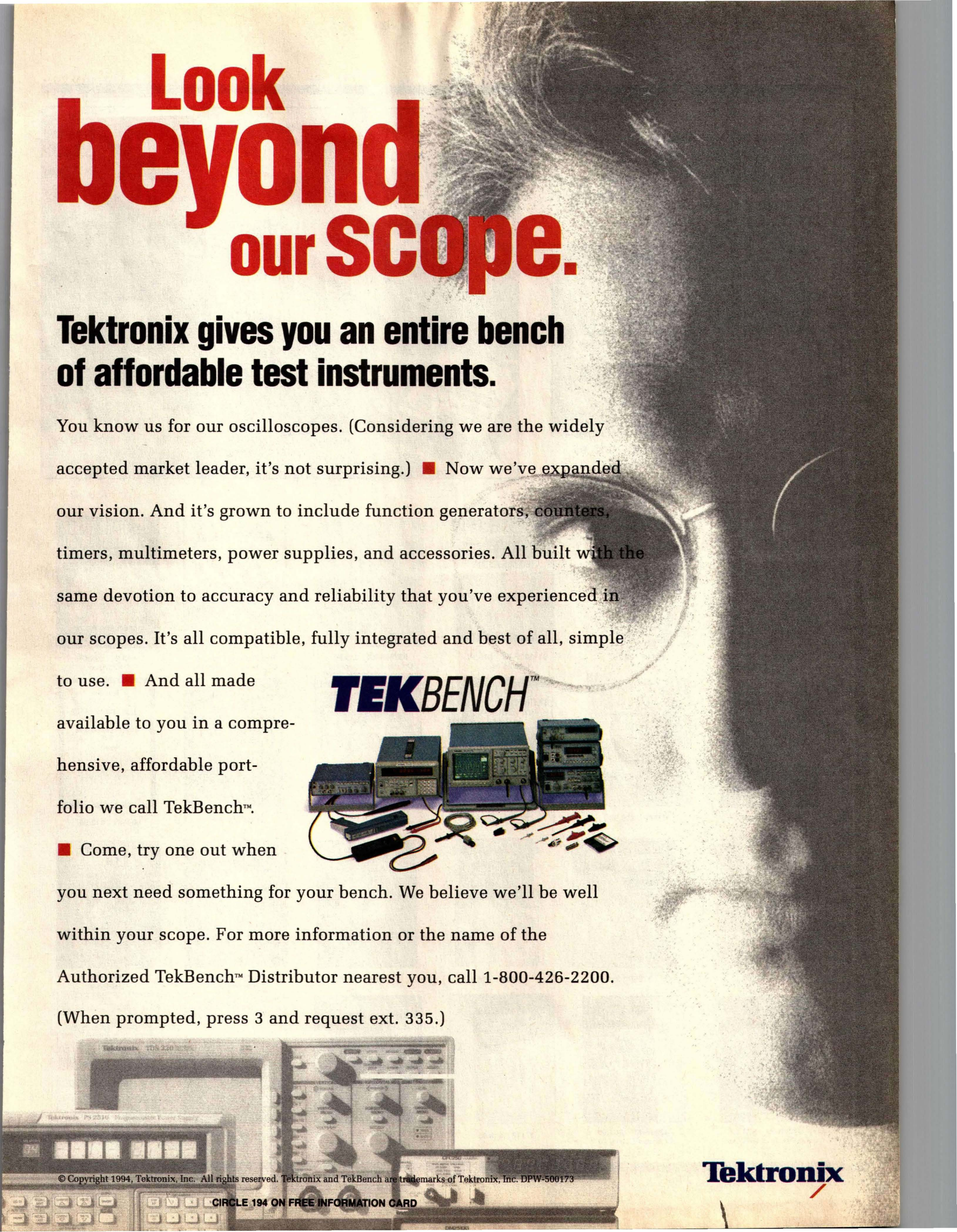
On the other hand, not enough has been said about the elegant, consistent design exhibited by OS/2 2.x and later versions. The reason is probably the large difference in usage between it and the most popular mainstream system.

The June '94 beta version of Windows 95 shows a typical Microsoft response to the migration problem. The W95 shell takes a step toward OS/2-like consistency and elegance, but fails to go all the way. Of course, because it is a beta, the shell can (and almost certainly will) change, but given Microsoft's history, I doubt that it will go as far as OS/2 has. This is a smart marketing move by Microsoft, and a risky one by IBM. But if history repeats itself, Microsoft's "not as good as it could be, but at least it's a step forward" approach will win, rather than IBM's "here's the solution to all your problems, just drop all current ways of doing things" approach. Don't get me wrong—I'd like to see IBM's approach win. But I think Microsoft's will win.

Tools, environments, and agents

Let's get back to the subject. The purpose of traditional user interface design is to build a link between two static objects, a computer and a user. The purpose of user interaction design is to build (1) tools and (2) an environment to ease and enhance the interaction among (3) two or more actors or agents. Let's now look at each component in more detail, in reverse order.

3. An actor or agent might be a



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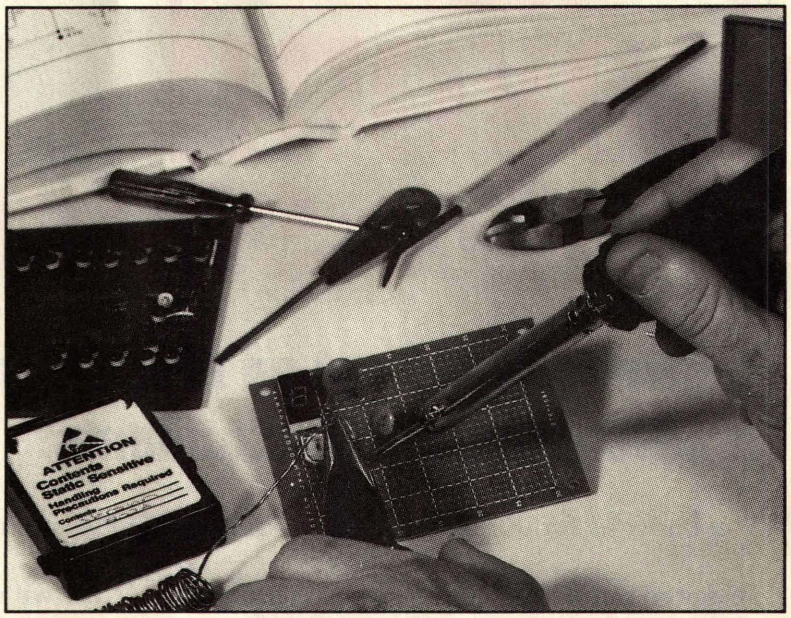
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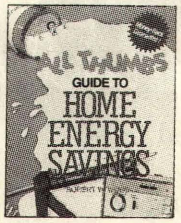
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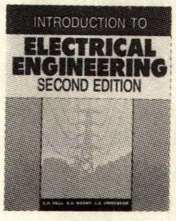
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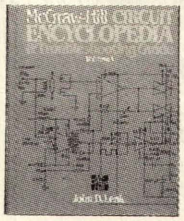
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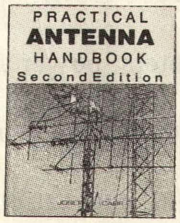
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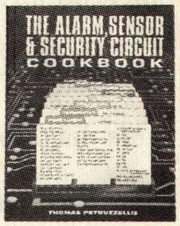
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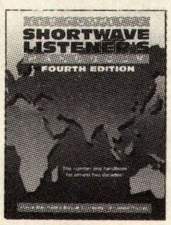
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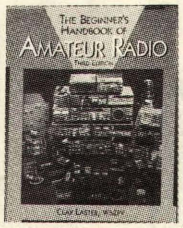
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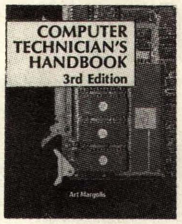
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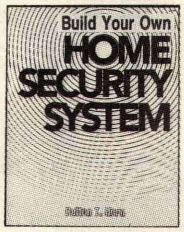
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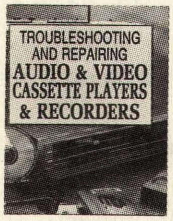
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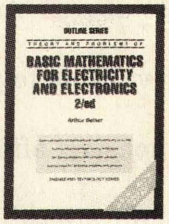
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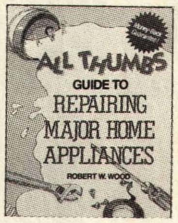
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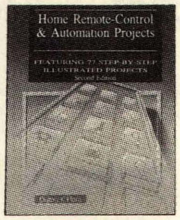
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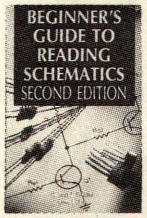
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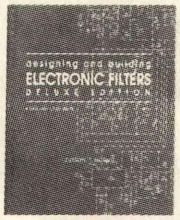
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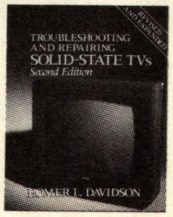
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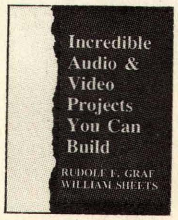
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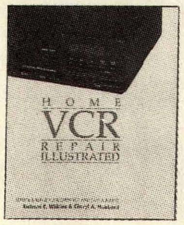
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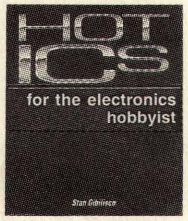
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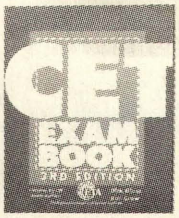
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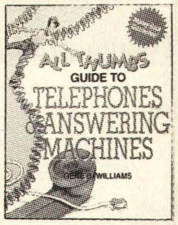
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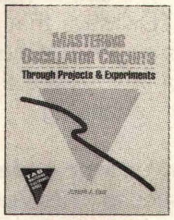
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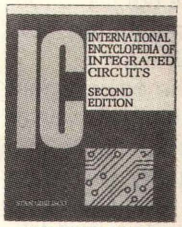
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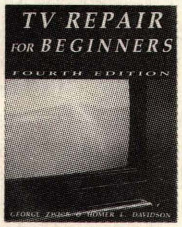
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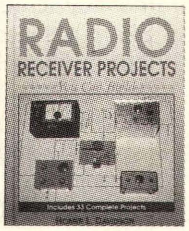
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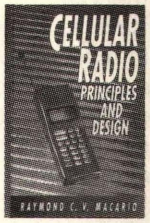
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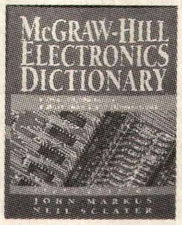
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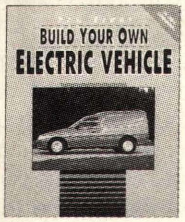
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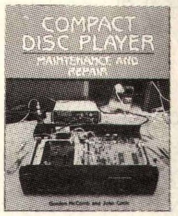
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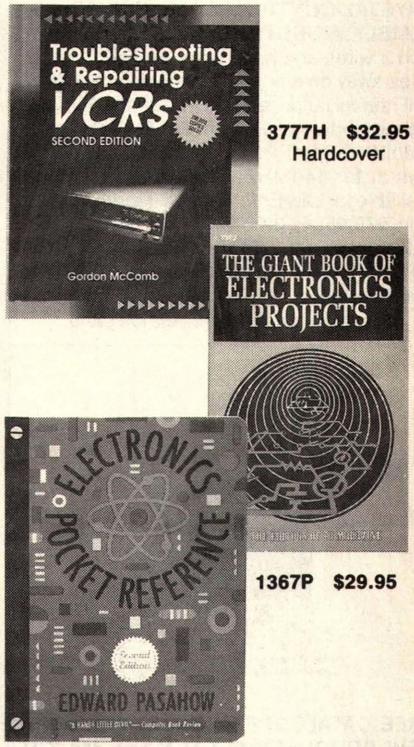
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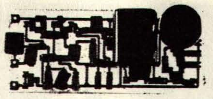

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person or a computer process.

2. A given environment might include one or more persons or processes. Processes might operate on one or more computers.

1. A tool is what I referred to easlier as a function or a collection of functions. A tool is designed and integrated within a conceptually unified architecture; it is not just a random collection of capabilities (the WordPerfect model).

More generally, the environment consists of everything perceivable—presently sight, touch, and sound, but eventually including taste and smell. It won't be long before so-called virtual reality technology gives rise to the VUI.

GUI-building tools such as Visual Basic and App Studio must evolve from being only drawing tools for creation of static screen objects, to become "interface" simulators that allow self-modifying actors to interact. In this scenario, user-interface design becomes less like a drawing activity, and more like specifying the rules of an expert system.

Objects

Object-oriented technology holds some promise for improving user-interface design. The reason has nothing to do with encapsulation, inheritance, or polymorphism. It is rather the real-world modeling that frequently accompanies o-o technology projects. The problem here is model proliferation. The human body is a good analogy. In it, multiple subsystems (circulatory, respiratory, nervous, skeletal, muscular) coexist and interact simultaneously. As software continues to increase in complexity, a similar concept is necessary so that user-interface design and implementation can proceed essentially independently of functional design and implementation.

The question then becomes how computer system design generally can evolve to support multiple simultaneously functioning and interacting subsystems explicitly. But that's a topic for another time. Meanwhile, don't let anyone fool you. There is much more to user interaction design than is obvious. As always, comments are welcome; email jkh@acm.org. Ω

VIDEO NEWS

continued from page 6

nounced that it will develop a recordable version next year. The TDK system will be a write-once type and is claimed to be much cheaper than proposed multi-recordable systems, which can erase and record many times. TDK says that its write-once system also will be much cheaper than rewritable types that use phase-change technology.

• **"Multimedia" camcorder.** Building on the success of its Viewcam—which combines an LCD monitor screen with a camcorder—Sharp has introduced a new version that doubles as a communications device. Sharp is calling it the first multimedia camcorder. The new top-of-the-line Viewcam contains a four-inch LCD color monitor with excellent resolution. It has connectors built into its base so that it can be placed on a stand (included with the camcorder) that connects it to a TV for playback. But that's not the only use for the connectors in the bottom of the machine. The camcorder also docks easily onto an extra-cost "Viewcamteleport" that has a built-in telephone jack. Also in the teleport is a solid-state memory device capable of storing 10 still color pictures, which can be selected from the tape in the camcorder, photographed live, or adapted form any other video source.

The teleport-equipped camcorder can send pictures via a standard phone connection to any other similarly equipped Viewcam. At the receiving end, the teleport can store up to 10 pictures in its solid-state memory for later viewing—either on the Viewcam's LCD screen or on a TV set. The digital transmissions provide three grades of picture, depending on transmission time—8, 11, or 20 seconds per picture. At a recent demonstration, the 20-second version was undistinguishable from the original.

The teleport also includes an audio-visual telephone answering system. If the called party doesn't answer, a recorded voice says: "Please transmit a video picture or

Continued on page 90

The theft of video signals has cable-TV and satellite-TV programmers aggressively pursuing signal pirates.

Signal Theft

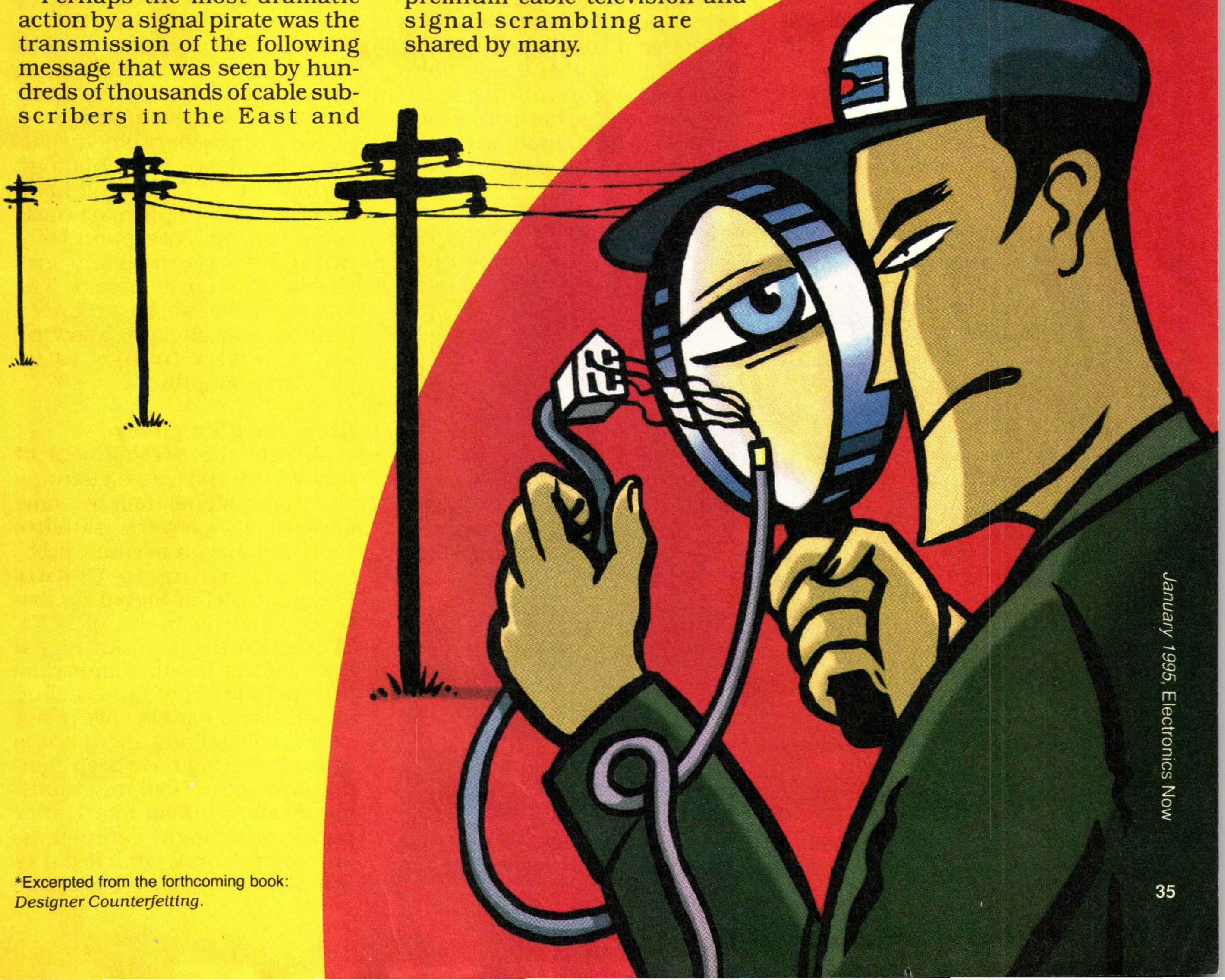
PAUL PARADISE*

VIDEO SIGNAL THEFT IS NOT NEW, it's hardly sensational, and it's rarely prosecuted. However, the cable-TV industry, by its own estimates, loses billions of dollars each year because of it. As the cable and satellite-TV industries prepare for new interactive technologies, they have become increasingly aggressive in trying to thwart signal pirates.

Perhaps the most dramatic action by a signal pirate was the transmission of the following message that was seen by hundreds of thousands of cable subscribers in the East and Midwest during an HBO cablecast of the movie *The Falcon and the Snowman*: "Good Evening HBO from Captain Midnight. $12.95 a month? No way! (Showtime/ The Movie Channel Beware.)"

The sender, who used a satellite uplink to superimpose his message on the HBO transmission, was eventually caught and prosecuted. But his sentiments regarding the rising cost for premium cable television and signal scrambling are shared by many.

In January 1986, HBO and Cinemax, both owned by Time, Inc. became the first two cable programmers to scramble their satellite signals, thereby preventing people who owned satellite-TV reception (or TVRO) systems from watching their programming without paying a monthly subscription fee.



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*Excerpted from the forthcoming book: *Designer Counterfeiting.*

In May, 1986 little more than a week after Captain Midnight's pirate broadcast, Showtime and the Movie Channel followed suit and scrambled their signals. Today, virtually all of the major cable networks scramble their satellite feeds.

Despite signal scrambling and a significant enforcement effort by the cable industry and the Motion Picture Association of America (MPAA) to apprehend illegal users, signal theft remains rampant. According to the National Cable Television Association (NCTA), almost one-quarter of all cable viewers in this country do not pay for the service. In 1992, the NCTA estimated that signal theft amounted to a loss to the cable industry of $4.75 billion.

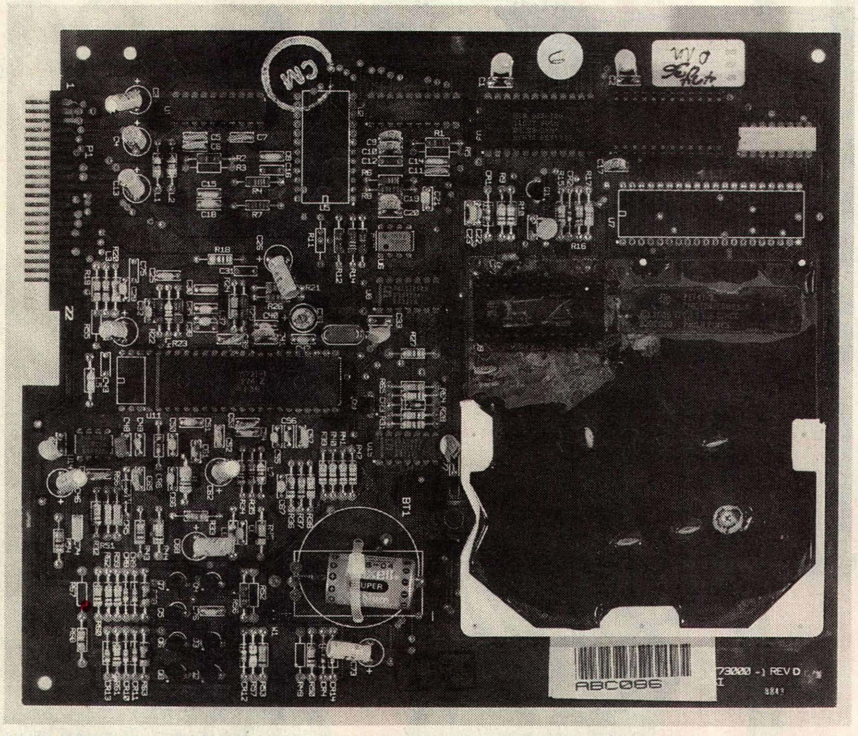
Satellite scrambling history

Signal theft grew in popularity with the growth of the home satellite TV market in the early 1980s. Home TVRO systems first became available in 1979 and were particularly attractive to TV-starved rural residents. At that time, a home satellite system cost $10,000.

In just a few years, the cost for satellite dishes dropped to $2,500, and demand for the dishes surged even in urban areas. Home TVRO systems became a growing concern to programmers. They worried that the availability of consumer satellite-TV systems would cause cable-TV subscriptions to plummet, thus reducing their revenues. The industry sought a way to prevent unauthorized viewers from watching their signals; the result was that programmers scrambled their satellite-delivered signals.

Signal scrambling upset consumers and dealt a major blow to the satellite-TV industry. Sales of satellite systems, which had reached 70,000 a month, fell to fewer than 15,000 a month. The early signal scrambling, however, spawned a new industry: illegal descrambling.

The scrambling method chosen by HBO that became the *de facto* standard for satellite-delivered television was VideoCipher II, developed by M/A-COM. VideoCipher II scrambles the video portion of the signal by replacing the horizontal- and vertical-sync signals with digital data. The digital data stream contains the audio portion of the signal, as well as the authorization codes or addresses of all legitimate descramblers. The digital data are encrypted with the data encryption standard or DES.



THIS EARLY VIDEOCIPHER II BOARD was compromised by signal pirates. Notice that the potting compound has been removed from around the microprocessor and EPROM socket.

Although the DES itself was never "beaten" by signal pirates, VideoCipher scrambling proved to be easy to defeat through several "back doors.". Descramblers, for example, were cloned so that a single legitimate subscription could turn on thousands of descramblers.

After pirates had compromised the security of VideoCipher II, General Instrument Corp., which bought the technology from M/A-COM, was forced to develop a new scrambling scheme called VideoCipher II Plus. The Plus system has yet to be successfully "hacked." The most recent version of the scrambling technology is VideoCipher Renewable-Security or VCRS.

The VCRS system has two features that make it resistant to piracy. First, developing a way to defeat the system would require a considerable investment in advanced technology. Second, the VCRS module has a provision to accept smart cards to update the encryption technology to counteract any "hacks" or security breaks. The smart cards can be produced quickly and cheaply, allowing any security breaks to be patched promptly.

Other Satellite piracy

Despite the development of the VCRS that has virtually eliminated signal theft by home satellite-TV viewers, satellite theft remains a serious problem, according to Dennis Powers, Chief of Signal Security, Legal Department of HBO. "The main focus of our signal theft efforts is the commercial misapplication of our satellite signal," said Powers. "We're not necessarily talking about boxes or modules that have been compromised or pirated, but multiple dwelling areas like trailer parks, apartment complexes, and recreational-vehicle parks that have set up their own cable systems under the guise of being TVRO installations. The pirate is paying a user fee, but is bringing down our signal and then redistributing it throughout the complex and charging a fee to each subscriber."

According to Powers, the illegal user is acting as an illegal distributor or illegal franchisee by selling the programming to other users who may, or may not, realize that he is doing so without authorization.

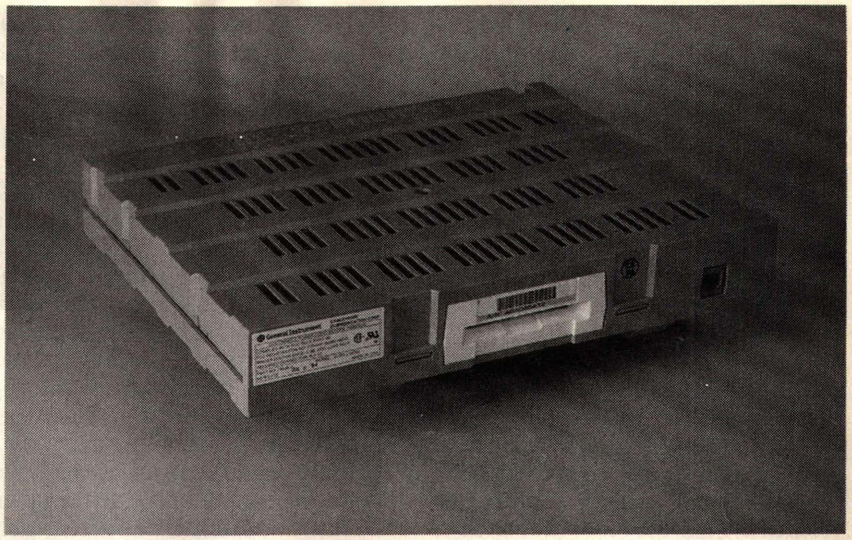
Other forms of satellite theft include sports bars that pick up sporting events not usually available on broadcast channels or cable networks.

Some sporting events that are distributed by satellite are not available in certain "blacked out" areas. For example, Major League Baseball has ruled that out-of-town games should not be made available anyplace where the home team is in action. That means that an avid fan of the San Francisco Giants who lives in New York would not be able to view his favorite team if either the Yankees or Mets were in action. The rules for NFL football prohibit a home game from being televised in the team's region if the stadium isn't sold out 72 hours prior to kickoff.

Such rules can be enforced by VideoCipher, which has the ability to black out programming according to ZIP codes. However, some TVRO system owners have been known to give incorrect address information when ordering program subscriptions so that they could watch programming that would otherwise have been blacked out to them.

Commercial establishments such as sports bars that masquerade as residences have been another problem. In this case, an establishment attempts to reduce its subscription fees by registering for a residential instead of commercial subscription.

Such satellite theft is difficult to trace. Leads for enforcement come in through many avenues, including rival sports bars that have legitimate program subscriptions. Agents who work for the major leagues or private investigators visit sports bars throughout the country to monitor what is being shown. Late last year, NFL Enterprises, Inc. filed civil suits against dozens of bars across the country for buying residential subscriptions to its NFL Sunday Ticket package. Residential subscriptions cost $139 for the football season, while commercial establishments pay from $600 to $2000, depending on their size.



A VCRS MODULE ready for insertion in a satellite-TV receiver. The smart-card slot provides for upgradable security.

To catch suspected signal pirates, NFL enterprises sent out teams of investigators to sports bars. During stops in play, the league caused all VideoCipher modules to display their identification numbers on the TV screen so that its investigators could note them and compare them against its subscription database.

Yet another form of satellite-signal theft occurs overseas. The Motion Picture Association of America (MPAA) has repeatedly cited the Caribbean area as a hotbed of piracy, both for pirated videocassettes and signal theft. However, the MPAA does not authorize cable programmers to distribute their services outside the U.S. If people in the Caribbean countries want cable services, they have no choice but to engage in signal theft.

"Technically, the footprint of the satellite signal is there," said Matthew Sappern, manager of corporate affairs for HBO. "HBO doesn't have the right to legally distribute and market its services outside the U.S. based on the covenants we have with the Hollywood studios." Because cable programmers lack distribution rights in the Caribbean area, their antipiracy efforts are hindered.

According to Powers, the Caribbean Cable Association is lobbying the MPAA in Hollywood to allow the programmers to distribute outside the U.S. The MPAA has thus far not granted distribution rights because of its release schedule for new movies. The release schedule is a marketing umbrella whereby new movies are released first to the U.S. theaters, then to the foreign theater market, before being released for videocassette distribution, cable television and network television. This prevents a movie from appearing in the theaters and on videocassette or cable television at the same time.

Direct-broadcast satellites

In October of last year, a new satellite service was rolled out nationally: the RCA Digital Satellite System which broadcasts digital video and audio signals from high-power direct-broadcast satellites (DBS). The three major players responsible for the launch are RCA/Thomson Consumer Electronics, DirecTV (a unit of General Motors Hughes Electronics), and

United States Satellite Broadcasting (U.S.S.B, a division of Hubbard broadcasting).

The DSS rollout has been enormously successful so far, with RCA selling virtually all the hardware it can produce—100,000 units a month, according to the company. More than one million receivers could be sold before the service is one year old.

The encryption and conditional-access system chosen for DSS, a completely digital system, was developed by the News Datacom division of Rupert Murdoch's News Corporation. The receiver accepts a smart card through a slot in its front panel, which allows the receiver to decode the programming that it is authorized for.

The rationale for choosing the system is that the smart card is difficult to reverse-engineer, yet is easy and inexpensive to upgrade and replace if a security break makes it necessary. In that way, it is similar to VCRS.

However, in Europe, a very similar system from News Datacom provides conditional access control for the Sky satellite service. The system has been repeatedly subjected to "hacks" by satellite pirates. Officials of the companies involved remain confident that any security breaks in the DSS encryption will be repaired quickly and inexpensively.

What the law says

Signal theft became a Federal crime under the Cable Communications Policy Act of 1984 [Title 47 USC, Section 605]. The Act states that "No person shall intercept or receive or assist in intercepting or receiving any communications service offered over a cable system, unless specifically authorized to do so by a cable operator or as may otherwise be specifically authorized by law." Satellite-delivered programming, because it is distributed primarily to cable companies, is also covered under the Cable Act.

The Act clearly mentions equipment used for signal theft. It states: "For the purpose of this section, the term assisting in intercepting or receiving shall include the manufacture or distribution of equipment intended by the manufacturer or distributor (as the case may be) for unauthorized reception of any communications service offered over a cable system."

For a first offense under the Cable Television Consumer Protection and Competition Act of 1992 [Title 47 USC, Section 553], a fine of $50,000 and imprisonment of up to two years, or both, may be handed down. A repeat offender can be fined up to $100,000 and imprisoned for more than five years.

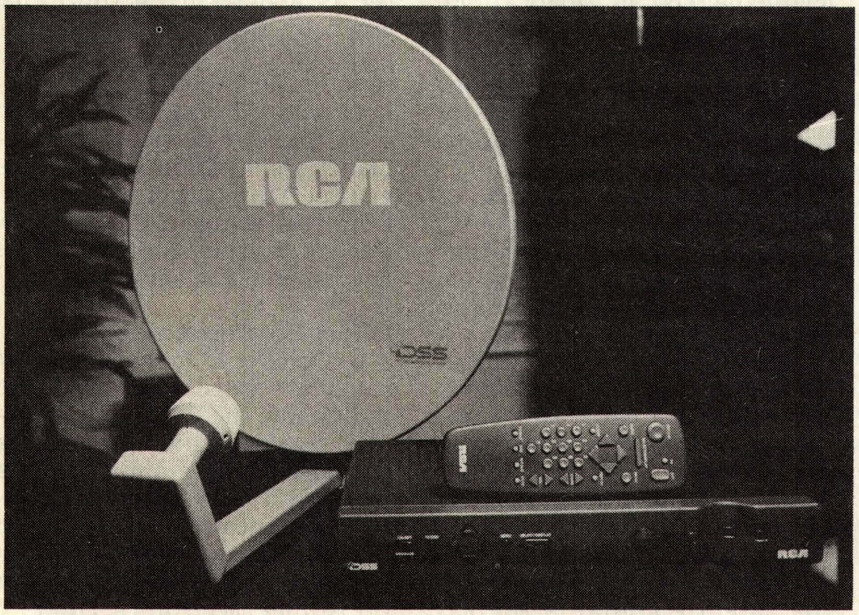
Only a manufacturer or distributor of illegal decoders or other descrambling devices is likely to receive imprisonment under the Cable Acts. A homeowner with no criminal record is not likely to go to jail for illegally connecting to the cable system. In many instances, the homeowner will be offered amnesty by the cable company and asked to subscribe.

"Our department performs many functions," says Bob Astarita, vice-president of security for Cablevision, the fifth largest Multiple Systems Operator (MSO) in the country. "One of the most critical is what we call a tap-audit function. Security technicians literally walk the system and make a determination if anyone is connected improperly or illegally."

In the first instance, according to Astarita, the illegal tap is treated as an unauthorized connection—one in which an individual is receiving programming through no fault of his own. That could happen, for example, if someone moved into an apartment and hooked his equipment up before determining that the prior occupant forgot to contact the cable company to have the service discontinued.

After the programming is cut off and the connection removed, a salesman will call and ask if the party would like to subscribe. If a tap audit discloses that the party is hooked up illegally a second time, it is treated as an illegal theft. The illegal connection is photographed and removed as evidence.

"Now you are illegal," says Henry Hack, director of investigations for Cablevision. "You have committed a crime. Theft of services is a Class A misdemeanor in New York State. You will be sent a cease-and-desist letter, and the security department will monitor the situation." No legal action will be



THE RCA DSS RECEIVER could be the next target for the concentrated efforts of pirates. The smart-card slot is located on the right side of the integrated receiver/descrambler or IRD.

taken unless the party hooks up for a second time. After the second offense, Cablevision will initiate either a civil action or a criminal action.

In a criminal action, a police officer will come to the house, determine that the party is hooked up illegally, and issue a desk appearance ticket. In New York State, theft of services is punishable by up to a $1000 fine or a year in jail. In most instances, if the homeowner has no criminal record, he will be able to plea bargain to a lesser offense. Most legal actions involve a civil suit. Damage awards start at about $1,500 in a civil suit.

"When I think of a pirate, I think of a seller or a distributor of illegal electronic products, not a homeowner," says Hack. "This is a business entity that advertises openly and is aware of the law." According to Hack, most illegal distributors do not sell in the states in which they are located to avoid prosecution under state law.

A typical brochure from a mail-order operation will display seemingly top-of-the-line equipment with brand names such as General Instrument, Panasonic, Toshiba and Scientific Atlanta. Usually, the channel converter, which can be legally acquired, will be offered for sale, along with the add-on or stand-alone descrambler—also called a starbase, a blackbox, a pancake, or a hotplate in the pirate trade.

In some instances, the equipment offered for sale is acquired from a cable operator who is about to upgrade the equipment in his franchise. In such cases, a distributor who buys the inventory that is to be upgraded diverts the equipment to a pirate operation.

"Piracy goes well beyond electronic hobbyists," Astarita said. "We encounter people who have Ph.D.s and others who have extensive backgrounds and degrees in many other academic disciplines."

Astarita, who is a former FBI agent, heads a staff of former law enforcement professionals. He and his staff conduct "buy-and-bust" operations and gather information to be used against pirate operations as part of their daily jobs.

THIS SPORTS BAR in New Jersey was sued for $1.4 million by Major League Baseball for showing out-of-town games without autorization.

Cable-signal theft can mean more than lost revenue to cable companies. One of the most serious problems caused by the proliferation of pirate electronic equipment is signal leakage. Hooking up an illegal decoder requires some technical expertise and the proper tools. A decoder that is not properly installed will cause signal leakage—radiation that poses a threat by interfering with commercial aircraft radio frequencies.

"We're supposed to be a closed system and there should be no leakage," said Hack. "The FCC does flyovers and measures the signal leakage, if the amount exceeds the cumulative leakage index (CLI), we will be fined heavily." Most cable operators have CLI teams who seek out potential signal leakage throughout the cable system.

Cable fights back

The technological battle between the cable companies and the pirates has led to some interesting anti-piracy devices, including the "electronic bullet." In April 1991, for example, American Cablevision of Queens, New York, filed suit against 317 cable customers who were pirating signals.

Jerrold Communications, a division of General Instrument Corp., learned that its converters were being compromised by an override chip. The black market chips were installed in a basic converter to obtain free premium programming. After obtaining several pirate devices, Jerrold engineers devised a strategy for outwitting the chip. The engineers invented a "bullet" that used the chip's own programs to neutralize it.

"The bullet is designed to blow out a box that has been tampered with," Hack explained. "Our computers talk directly to the decoders that we purchase from the manufacturer and tell it what to authorize. To use the bullet, we send a signal down the line that says: 'ignore the next message,' and the legitimate boxes will ignore the next message—the next message being: 'blow yourself up.' There is no frying or electrical charge or 'bullet'—just a deauthorization." Incredibly, the bullet succeeded because irate homeowners with pirated boxes—unaware that a "bullet" had been fired—called the cable company to complain about the lack of reception.

Despite the penalties afforded under the Cable Acts of 1984 and 1992, the sale of illegal equipment is rampant. Illegal decoders are offered for sale in electronics stores, through mail-order companies, and are even advertised in national magazines. The sale and advertisement of illegal decoders can be found throughout the country.

Will Nix who joined the Motion Picture Association of America (MPAA) in 1976 and was promoted to the title of Chief Operating Officer of the MPAA's anti-piracy division, participated in organizing a nationwide effort to combat signal theft. Nix left the MPAA in 1991.

According to Nix, at one time during the 1980's about fifty percent of the satellite decoders sold by General Instrument were being compromised by a illegal computer chips. "General Instrument wanted to transfer its in-house anti-piracy effort into a larger, national effort," Nix said. "We helped organize the Office of Cable Signal Theft (OCST) as a joint effort by the Satellite Communications Broadcast Association (SCBA) and the MPAA."

OCST was formed in 1986 and today is part of the National Cable Television Association, in Washington, D.C., and funded by both the NCTA and the MPAA. OCST works closely with the Department of Justice, the F.B.I., U.S. Customs, state and local prosecutors, as well as law enforcement agencies throughout the country. OCST provides assistance to these enforcement agencies in prosecuting criminal violators. In the last three years, OCST has been involved in the seizure of 400,000 illegal decoders.

"Another organization that I assisted in forming is the Coalition Opposing Signal Theft (COST)," Nix said. "COST was set up as a joint venture between the NCTA and the MPAA, and was designed to address issues in the area of signal theft."

Many of the more than 10,000 cable operators are members in the OCST and COST, which is part of the OCST advisory committee. Mr. Astarita is the current vice-chairman of COST.

The inside problem

"When I first moved into Manhattan, the cable technician who hooked me up asked if I wanted to do this the legal way or the illegal way," said HBO's Matthew Sappern.

For some cash, the cable technician was offering to hook up the premium channels for Sappern, who would thereafter receive them for free. Sappern's experience is by no means an isolated one. Moreover, the largest source of illegal decoding devices on the black market today is cable operators themselves. It is estimated that as much as 90% of the market in illegal decoders can be traced back to the cable operators. It should be noted that in many instances, a cable operator who is upgrading his equipment will unknowingly sell his existing inventory to a distributor who, in turn, will divert the inventory to an illegal use.

"We at Cablevision are aware that a great deal of the illegal product comes from within," Astarita explained. "Cablevision monitors what happens to its old cable boxes, and in some instances we destroy the boxes if we cannot sell them to a reputable source."

Cablevision prides itself on being a leader in the field of addressing theft. It conducts due diligence inquiries on contractors and vendors with whom it does business. It will sell old cable products only to a distributor who can document the inventory's destination or to a licensed franchise cable operator.

Future problems?

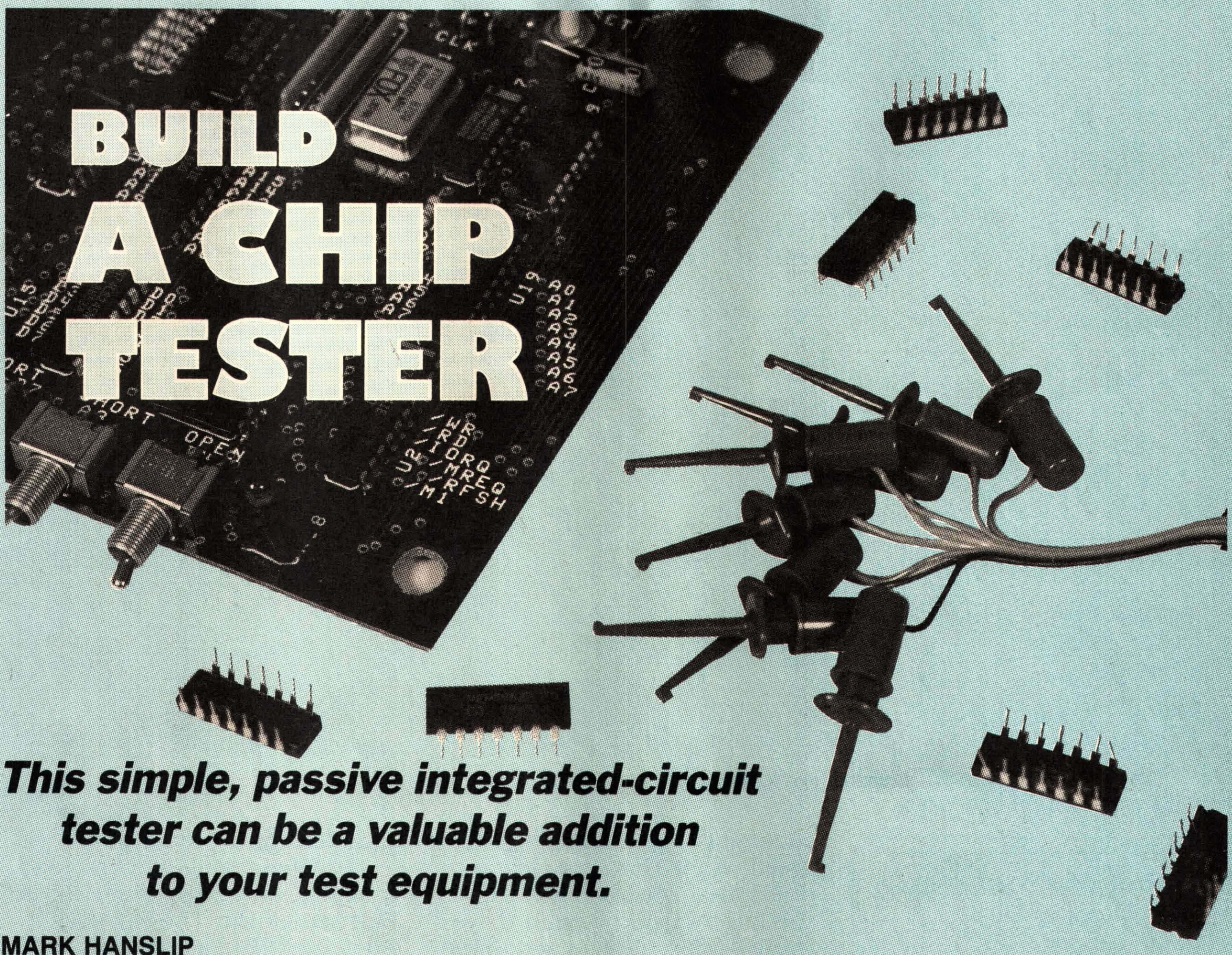
Interactive television will dramatically change the content of cable programming and the problem of signal theft. In late 1994, Time Warner Cable Systems was scheduled to introducing interactive television to some 4000 homes in Orlando, Florida. The Orlando project will cost about $5000 per household. Digital Equipment Corp. and General Instrument Corp. are joining forces to produce the interactive equipment, which will combine DEC's microprocessor, distribution, and storage technologies with GI's encryption system that allows financial and other information to be sent confidentially.

The Orlando endeavor is the largest of many interactive television projects that will get underway this year. Interactive television will ultimately change the concept of the cable operator, who will be offering much more than simple television programming. EMInteractive television is the result of a merger of the technologies of many industries: computer, cable, television and telephone. Interactive television will allow the subscriber to 'interact' with the television. In the envisioned systems, the interactive cable subscriber will be able to talk face to face with his neighbor or his employer, shop and bank from his television, and view conventional television programming as well. Virtually all of the signals for interactive TV will be digital.

In June 1994, British television viewers got their first introduction to interactive television. Two commercial broadcasters, Carlton Television and London Weekend Television, joined forces with a cable operator to offer an experimental interactive London news channel. The cable operator's 65,000 subscribers can choose from four channels of programming to concentrate on weather, traffic, community and social action reports or the regular news program. In 1995, the cable operator hopes to introduce interactive programming that will allow the viewer to communicate with the studio. Viewers will be able to vote on programs or the performance of a politi-

Continued on page 90

BUILD A CHIP TESTER



This simple, passive integrated-circuit tester can be a valuable addition to your test equipment.

MARK HANSLIP

A TESTER FOR INTEGRATED CIRcuits can be passive or active. An active tester determines how a device reacts to a set of input signals. It can determine if an IC is faulty, but only if the device is removed from its host circuit.

The passive tester described here can test ICs in a circuit, and does not need to be reconfigured for each device to be tested. A passive tester can also function as a logic analyzer to monitor input and produce output signals.

This article describes how to design, build, and use a simple, inexpensive passive IC tester that can be a valuable addition to your suite of test equipment. But keep in mind that the tester is designed for testing TTL and CMOS devices powered by +5 volts, only.

The tester can test devices with any number of pins. The author designed his prototype to test ICs with up to 20 pins. Chips with 8 to 20 pins that are packaged in DIPs (dual in-line packages) usually have the same width and pin spacing. Thus if a zero-insertion-force (ZIF) socket is added to the intergrated-circuit tester, it will be able to accept most 8-, 14-, 16-, 18-, and 20-pin ICs.

The IC tester puts one or more pins of a known good device in parallel with the corresponding pins of a suspect device. The tester then lights one LED lamp if differences are found in the signals between any matching pins, and other LEDs on the tester light up to show where those differences are.

Circuit design

A typical input circuit is shown at left in the Fig. 1 schematic; one is needed for each test pin. (Only one input circuit is shown. It can test only one suspect pin at a time, but the tester can be built with as many input circuits as you need. Connect additional input circuits to the latch circuit via the 1N4148 diodes as shown in the schematic.) The 74LS266 is an open-collector quad EXCLUSIVE NOR (XNOR) gate. One input to each 74LS266 gate is attached to one pin of the device under test (DUT), and the other input is attached to the same pin of the "good" chip. A single 74LS266 can accommodate up to four inputs, although only a single input is shown in the schematic.

When the two inputs to a 74LS266 gate are the same (e.g., pin 3 of the DUT and pin 3 of the reference device), the output is high; when the inputs differ, the output is low.

Multiple 74LS266 output signals are added together through a series of 1N4148 diodes which are connected to the latch circuit. Only a single latch circuit is needed for the entire tester. After power is applied to the tester, push reset button S1 to initialize the circuit. The reset

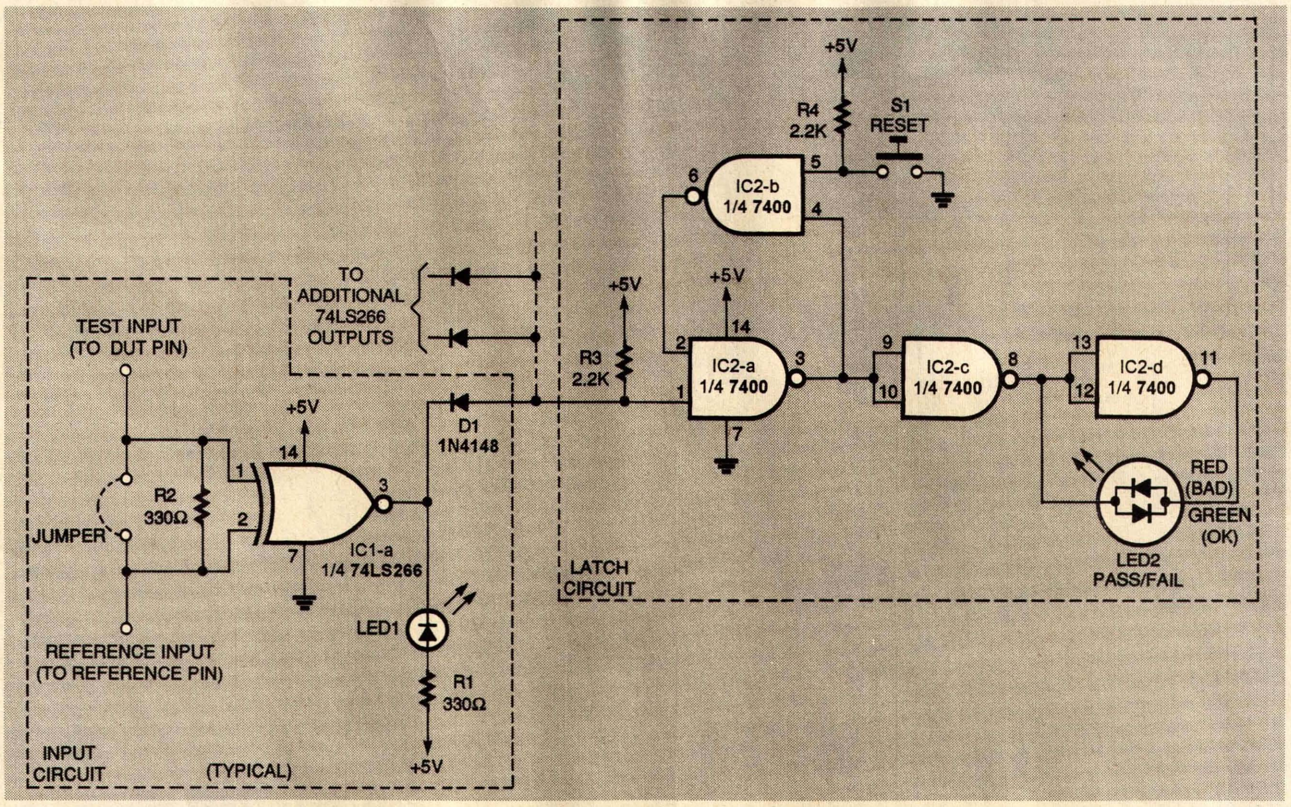

+5V
R4
2.2K
S1
RESET
5
6
IC2-b
1/4 7400
4
TO
ADDITIONAL
74LS266
OUTPUTS
+5V
+5V
14
TEST INPUT
(TO DUT PIN)
R3
2.2K
2
IC2-a
1/4 7400
3
9
IC2-c
1/4 7400
8
13
IC2-d
1/4 7400
11
1
10
12
+5V
D1
1N4148
7
14
1
R2
330Ω
2
3
JUMPER
IC1-a
1/4 74LS266
7
RED
(BAD)
GREEN
(OK)
LED2
PASS/FAIL
LATCH
CIRCUIT
LED1
REFERENCE INPUT
(TO REFERENCE PIN)
R1
330Ω
INPUT
CIRCUIT
(TYPICAL)
+5V

FIG. 1—THIS SIMPLE IC TESTER compares two logic signals and indicates whether the signals are the same or different.

THE BURNING MUST STOP. NOW!

Rain forests occupy just 2% of the earth's surface. Yet, these rain forests are home to half of the planet's tree, plant and wildlife species. Tragically, 96,000 acres of rain forest are burned every day.

You can help stop this senseless destruction. Right now you can join The National Arbor Day Foundation, the world's largest tree-planting environmental organization, and support Rain Forest Rescue to stop further burning.

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Call Rain Forest Rescue.
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causes bi-color LED2 to light up green. After that, any low output from a 74LS266 will trigger the latch circuit which drives the bi-color LED to red. That color indicates that at least one pin of the DUT doesn't agree with the good chip. The faulty pin is flagged by the LED (LED1 in Fig. 1) attached to the corresponding gate's output. Press the reset pushbutton again to start a new test.

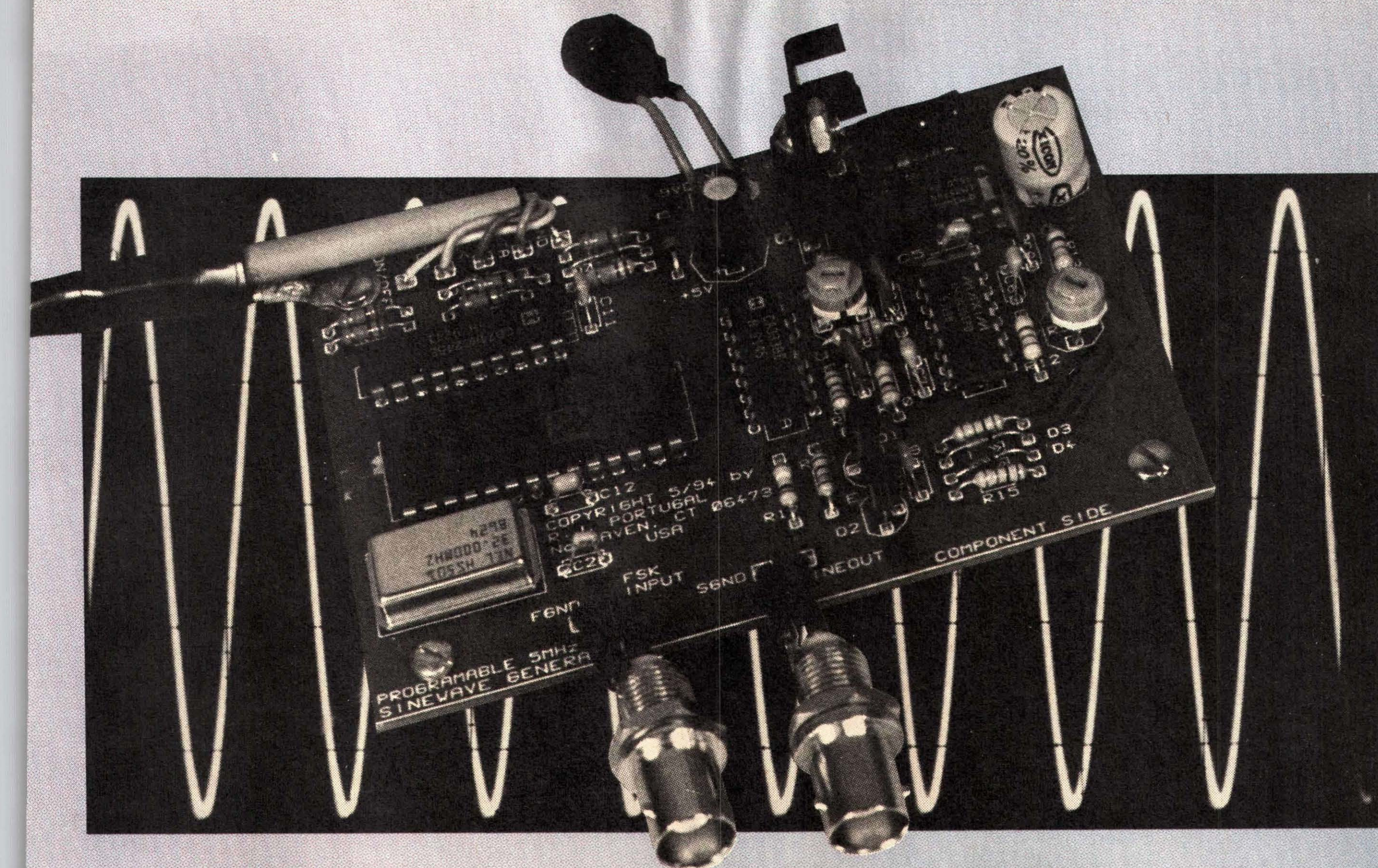
The 330-ohm resistor that parallels the comparator's inputs (R2) allows the signals to the DUT to flow to the reference IC as well. That resistor also prevents the output of the DUT from affecting the reference IC. The jumper that parallels the resistor can short circuit the ground and +5-volt pins of the DUT to the reference IC so the reference IC can be powered by the DUT circuit. Power for the remainder of the test circuit (LED, comparators, and latch) must come from an external power supply.

Remember that the tester is designed for testing 5-volt TTL and CMOS devices only. *To prevent damage, do not exceed that voltage on any pin.*

The tester can be converted to a logic analyzer by inserting a DIP header into the test socket. All of the DIP header pins except the power pin should be connected together and grounded. This will allow you to monitor the signals going to and coming from the DUT with the green LEDs.

Tester use

To use the tester, first connect the test input to the suspect pin of the DUT. Next, connect the reference input to the same pin of an identical reference chip that is known-to-be-good. Push the reset button to begin the test; the green section of the bi-color LED will be illuminated. Any signal on the test device that differs from the one on the reference device will then momentarily light the LED lamp that corresponds to that pin, and also latch on the red section of the bi-color LED. That indicates that the device under test is faulty. If the reference and DUT signals are the same, the DUT is OK, and the green LED will remain lit. Ω



PROGRAMMABLE SINEWAVE GENERATOR

RONALD J. PORTUGAL

Build this programmable sinewave generator once, and you can program it forever!

A PROGRAMMABLE SINEWAVE GENERATOR can be a lot more accurate than an analog-based generator. When teamed with a PC or single-board computer, a programmable generator becomes an application-specific instrument offering a limitless variety of software-based "front panels" without the need to modify the hardware. It's a fun device to build and experiment with. Plus, you have to build it only once, but you can program it forever.

There are many tasks that can be performed with a programmable sinewave generator (PSG):

- Convert RS-232 signals to audio or RF frequency FSK (frequency shift keying) format for phone line or wireless modem transmitters
- Function as a signal source for bode plots
- Function as a linear, log, discrete, or programmed sweep generator
- Act as a local oscillator and carrier frequency generator for a transceiver
- Function as a general-purpose generator for industry, education, and experimenter labs
- Synthesize single-voice music compositions
- Generate telephone keypad tones
- Synthesize voice or sound
- Act as a general-purpose secondary frequency standard
- Generate frequency bursts
- Generate continuous-wave amplitude modulation
- Provide a stable, accurate voltage-controlled oscillator for amateur radios
- Generate automatic-test-equipment sweep signals

A computer's parallel port is ideal for controlling a PSG because the parallel port is easy to use, and there is one in most personal computers made today—including most laptop models. Although the serial port could be used, the required

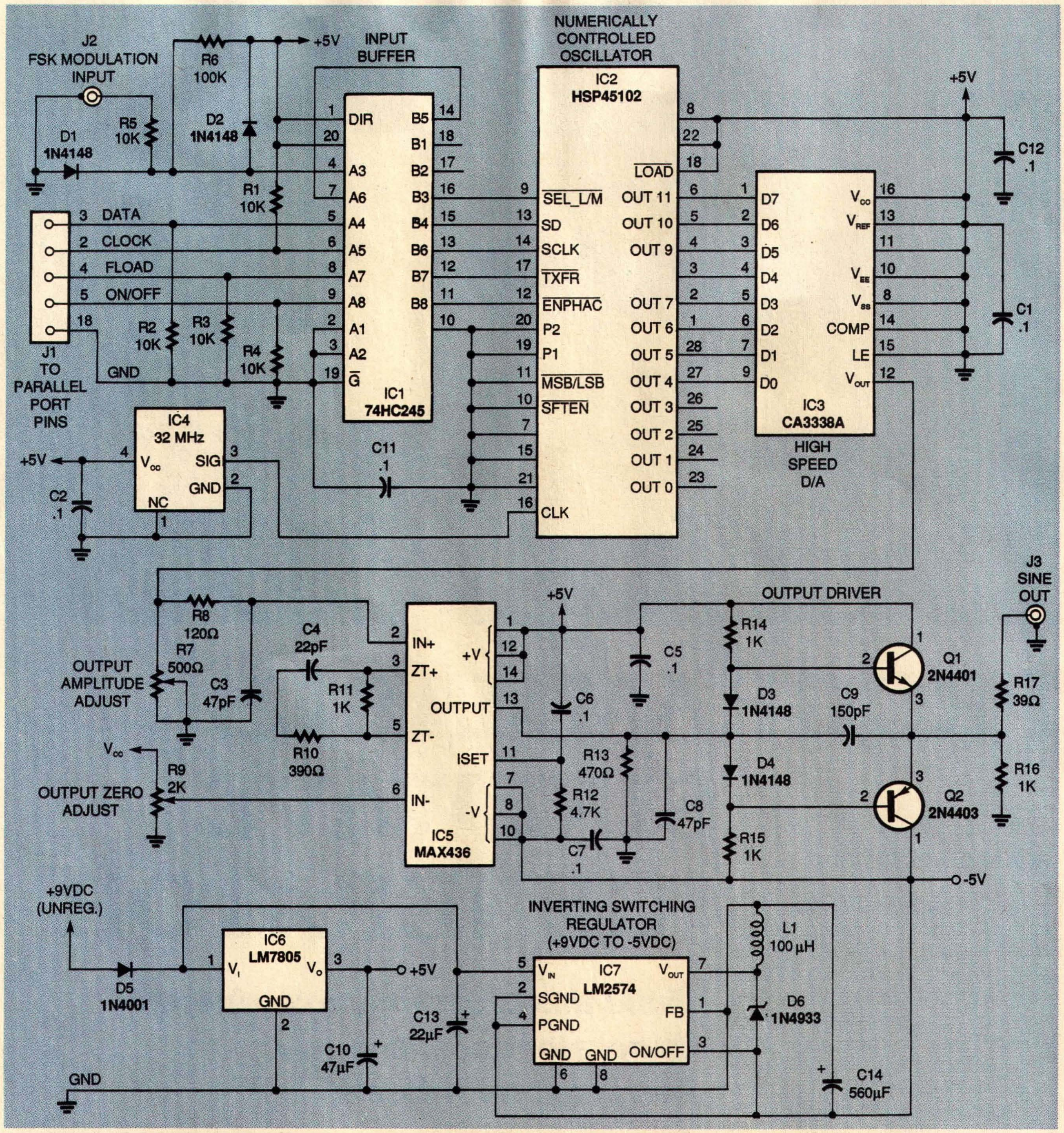

J2
FSK MODULATION
INPUT
D1
1N4148
R5
10K
R6
100K
D2
1N4148
R1
10K
+5V
INPUT
BUFFER
NUMERICALLY
CONTROLLED
OSCILLATOR
IC2
HSP45102
+5V
C12
.1
3 DATA
2 CLOCK
4 FLOAD
5 ON/OFF
18
J1
TO
PARALLEL
PORT
PINS
GND
R2
10K
R3
10K
R4
10K
DIR
A3
A6
A4
A5
A7
A8
A1
A2
G
B5
B1
B2
B3
B4
B6
B7
B8
IC1
74HC245
SEL_L/M
SD
SCLK
TXFR
ENPHAC
P2
P1
MSB/LSB
SFTEN
CLK
LOAD
OUT 11
OUT 10
OUT 9
OUT 7
OUT 6
OUT 5
OUT 4
OUT 3
OUT 2
OUT 1
OUT 0
D7
D6
D5
D4
D3
D2
D1
D0
V_{CC}
V_{REF}
V_{EE}
V_{SS}
COMP
LE
V_{OUT}
IC3
CA3338A
HIGH
SPEED
D/A
C1
.1
IC4
32 MHz
V_{CC}
SIG
GND
NC
+5V
C2
.1
C11
.1
R8
120Ω
R7
500Ω
OUTPUT
AMPLITUDE
ADJUST
C3
47pF
C4
22pF
R11
1K
R10
390Ω
V_{CC}
R9
2K
OUTPUT ZERO
ADJUST
IN+
ZT+
ZT-
IN-
+V
OUTPUT
ISET
-V
IC5
MAX436
+5V
C5
.1
C6
.1
R13
470Ω
R12
4.7K
C7
.1
C8
47pF
OUTPUT DRIVER
R14
1K
D3
1N4148
D4
1N4148
R15
1K
C9
150pF
Q1
2N4401
Q2
2N4403
J3
SINE
OUT
R17
39Ω
R16
1K
-5V
+9VDC
(UNREG.)
D5
1N4001
IC6
LM7805
V_I
V_O
GND
+5V
C10
47µF
C13
22µF
GND
INVERTING SWITCHING
REGULATOR
(+9VDC TO -5VDC)
IC7
LM2574
V_{IN}
SGND
PGND
GND
GND
V_{OUT}
FB
ON/OFF
L1
100µH
D6
1N4933
C14
560µF

FIG. 1—PSG SCHEMATIC. The NCO chip is a serial input device that needs either 32 or 64 bits of data to generate sinewaves; 32 bits are required for single-frequency operation and 64 bits are required for dual-frequency (FSK) operation.

interface would be more complex, hardware-intensive, and expensive.

The heart of the PSG is an HSP45102 numerically controlled oscillator (NCO). The frequency to be generated is selected from two frequency control words. A single control pin selects the word that determines the output frequency. Switching from one frequency to another occurs in one clock cycle, with a six-clock-pulse pipeline delay from the time that the new control word is loaded until the new frequency appears at the NCO's output. Twelve-bit binary words selected from the chip's internal memory are fed to a Harris CA3338A digital-to-analog converter (DAC) that generates the synthesized sinewave output.

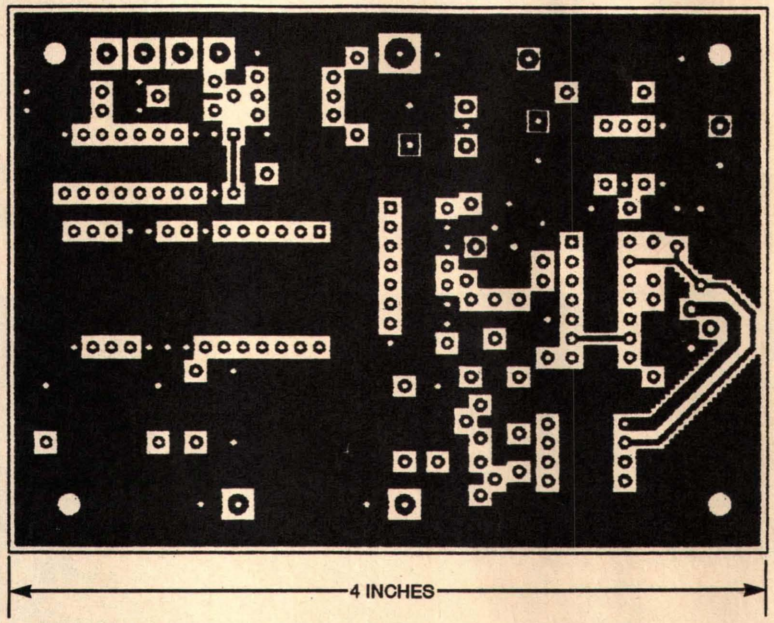
Once the sinewave has been synthesized, it is level-shifted to be symmetrical around zero volts and then filtered to remove the remaining components of the high-frequency NCO clock frequency (32 MHz). Finally, the sinewave is buffered and fed to the PSG's output.

How does it work?

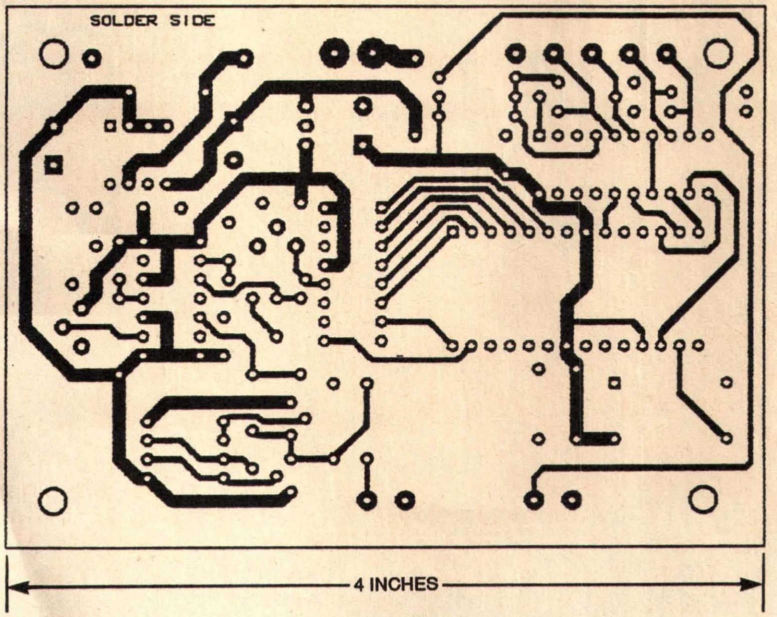
Refer to the upper left-hand corner of the schematic, Fig. 1. The DATA, CLOCK, FLOAD, and ON/

TABLE 1

PARALLEL PORT DB25 PIN NO.	9	8	7	67	5	4	3	2
DATA PORT BIT	D7	D6	D5	D4	D3	D2	D1	D0
BIT WEIGHT	128	64	32	16	8	4	2	1
BIT FUNCTION	X	X	X	X	ON/OFF	FLOAD	DATA	CLOCK



PSG COMPONENT SIDE.



PSG SOLDER SIDE.

OFF input lines couple the board to a PC's parallel port. Each of the four inputs is buffered by IC1 and then fed to the HSP45102 NCO chip. The NCO chip is a serial input device that needs either 32 or 64 bits of data to start generating sinewaves; 32 bits are required for single-frequency operation and 64 bits are required for dual frequency shift keying (FSK).

A shift-clock pulse is generated by the PC with each data bit fed to the DATA input, and it is fed to the CLOCK input of the NCO. When all 32 (or 64) data bits have been fed to the NCO, the FLOAD line is activated and the new frequency(s) become available at the output of the generator. The ON/OFF control line turns the output signal on or off under program control.

The TTL-compatible FSK modulation input selects one of the two programmed frequencies to be seen at the output of the instrument. For example, assume the two programmed frequencies are 1.0001 megahertz and 0.9999 megahertz . A high level (TTL logic 1) at the FSK input would cause the 1.001-megahertz signal to appear at the output, while a low level (TTL logic 0) would cause the 0.999 megahertz signal to show up at the output. The switching delay between signals is six clock pulses—in this case, 187.5 nanoseconds.

The FSK input is held high by 100K resistor R6 to ensure that the first 32 bits of input data activate the NCO. The FSK input is protected from negative voltages by D1 and voltages in excess of +5 volts by D2.

When the NCO has received valid data, it computes the location of the sinewave amplitudes (stored in ROM) needed to generate the output signal. For example, if a 1-megahertz sinewave has been requested, the NCO computes the location of the 32 amplitude values necessary to make up the 1-megahertz sinewave (F_{CLK}/F_{OUT} = number of amplitude values) and then sends the binary values in a 12-bit format to 12 output lines at a 32-megahertz rate (every 31.25 nanoseconds). A digital-to-analog converter (DAC) connected to the NCO's output lines converts the amplitude values to analog voltages. A 12-bit, 31.25-nanosecond-settling-time DAC is needlessly expensive, so an 8-bit DAC is substituted. The DAC's vertical resolution, better than 0.4%, is adequate for this application.

The amplitude of the DAC output signal is controlled by R7 while the sinewave DC zero level is set by R9. The DAC output (0 to +5 volts unloaded) must be level-shifted to produce a sinewave symmetrical around zero volts. It also must be filtered to produce clean sinewaves.

Because the number of samples per sinewave cycle is equal to the ratio of the clock frequency and the desired output frequency, it can be seen that at 5 megahertz, the number of samples forming the sinewave will be 6.4 (32 MHz/5 MHz), which is a pretty "steppy" sinewave.

The two problems, filtering and level-shifting, are solved by the Maxim MAX436 wideband transconductance amplifier IC5. A transconductance amplifier is a true differential amplifier with high-impedance inputs. It provides accurate gain without negative feedback, eliminating closed-loop phase shift. This is the main cause of oscillation in voltage-output, high-speed amplifiers. The output of the transconductance amplifier is a current that is proportional to the differential input voltage, and the amplifier is virtually short-circuit proof. The gain of the circuit is set by the ratio of two external impedances and an internal current gain factor K:

$$\text{Gain} = K(Z_{LOAD}/Z_T)$$

The device also has a bandwidth in the 275-megahertz range with an 800-volt-per-microsecond slew rate.

For level-shifting, R9 is connected between +5 volts and ground with its center tap fed to the negative input terminal of the MAX436. Simply adjust R9 so that the output signal is symmetrical about ground.

Three resistive-capacitive (RC) sections are distributed throughout the circuit. The first section consists of the output impedance of DAC IC3, R7, R8, and C3. The second is comprised of R13, the output impedance of the transconductance amplifier, the input impedance of the complementary

PARTS LIST

All resistors are ¼-watt, 5%, unless noted.

R1–R5—10,000 ohms
R6—100,000 ohms
R7—500 ohms, ¼-inch round, single-turn cermet trimmer potentiometer
R8—120 ohms
R9—2000 ohms, ¼-inch round, single-turn cermet trimmer potentiometer
R10—390 ohms
R11, R14–R16—1000 ohms
R12—4700 ohms
R13—470 ohms
R17—39 ohms
C1, C2, C5–C7, C11, C12—0.1µF, ceramic
C3, C8—47 pF, 5%, ceramic NPO
C4—22 pF, 5%, ceramic NPO
C9—150 pF, 5%, ceramic NPO
C10—47 µF, 25 volts, electrolytic
C13—22 µF, 25 volts, electrolytic
C14—560 µF, 16 volts, electrolytic

Semiconductors

IC1—74HC245 octal non-inverting bus transceiver
IC2—HSP45102 12-bit numerically controlled oscillator (Harris)
IC3—CA3338A 8-bit DAC (Harris)
IC4—NEL HS501 32-MHz clock oscillator module (Mouser No. 332-3320 or equivalent)
IC5—MAX436 wide-band transconductance amplifier (Maxim)
IC6—7805, 5-volt regulator (TO-220 package, Motorola or equivalent)
IC7—LM2574-5 inverting switching

LISTING 1

```
'***************************************************************************
'*                       PSG CONTROL PROGRAM                               *
'*      COPYRIGHT 5/94 by R.J. PORTUGAL, NORTH HAVEN, CT. 06473, U.S.A     *
'***************************************************************************
DECLARE SUB FREQUENCY (L1, L2, FLAG)        '**** Frequency input routine
DECLARE SUB FREQCLR (L1, L2)                '**** Clear frequency entries
DECLARE SUB LOAD ()                         '**** Parallel-serial data convert
DECLARE SUB ERMSG (L1, L2)                  '**** Error messages
DECLARE SUB DSPLY ()                        '**** Display screen

COMMON SHARED FMT$, N1&, N2&, K, DP, PORT$, MSG$(), L1, L2
DIM Z AS STRING * 1: DIM MSG$(20)
FMT$ = "###,###,###,###.####": Clk = 32000283: K = (2 ^ 32 / Clk)

'***************************************************************************
'       To select NCO parallel printer remove the (') "comment symbol"
'       in front of the appropriate program line.
'       PRINTER PORT "LPT2" will be selected by the following:

     'port$ = "LPT1": dp = &H3BC      '*** LPT1 DATA PORT ADDRESS
      PORT$ = "LPT2": DP = &H378      '*** LPT2 DATA PORT ADDRESS
     'port$ = "LPT3": dp = &H278      '*** LPT3 DATA PORT ADDRESS
'***************************************************************************
'********** (Message list) **********
MSG$(1) = "           Input range is from 0.00Hz to 10,000,000.00Hz           "
MSG$(2) = "       Program accepts numerals and a single decimal point        "
MSG$(3) = STRING$(64, " "): MSG$(4) = STRING$(21, " ")
MSG$(5) = "Last input not transferred to NCO": MSG$(6) = STRING$(50, " ")
MSG$(7) = "PSG output signal OFF"
MSG$(8) = "PROGRAMMABLE SINEWAVE GENERATOR CONTROL SCREEN"
MSG$(9) = "PSG printer port is " + PORT$ + ".  "
MSG$(10) = PORT$ + " uses I/O port " + HEX$(DP) + "HEX"
MSG$(11) = "COPYRIGHT 5/94 by R.J. PORTUGAL, NORTH HAVEN, CT. 06473, U.S.A."

COLOR 15, 1: CLS : CALL DSPLY: N1& = 0: N2& = 0: CALL LOAD
'---------------------------------------------------------------------------
DO: K$ = INKEY$                                '*** Main Program
IF LEN(K$) = 2 THEN          'check keyboard entry for 2 character scan code
      IF ASC(RIGHT$(K$, 1)) = 59 THEN CALL FREQUENCY(5, 6, 1)       '**** [F1]
      IF ASC(RIGHT$(K$, 1)) = 60 THEN CALL FREQUENCY(8, 9, 2)       '**** [F2]
      IF ASC(RIGHT$(K$, 1)) = 61 THEN                               '**** [F3]
        N1& = 0: N2& = 0: CALL LOAD
        CALL FREQCLR(5, 6): CALL FREQCLR(8, 9)
      END IF
      IF ASC(RIGHT$(K$, 1)) = 62 THEN CALL LOAD          '*** [F4]
      IF ASC(RIGHT$(K$, 1)) = 63 THEN                    '*** [F5]
COLOR 6 + 16, 7: OUT DP, 1 + 8                           '*** nco clock off
LOCATE 15, 40 - LEN(MSG$(7)) / 2: PRINT MSG$(7)          '*** Prints message
DO: K$ = INKEY$: LOOP UNTIL K$ = CHR$(0) + CHR$(63)      '*** Wait for "F5" key
COLOR 15, 1: LOCATE 15, 40 - LEN(MSG$(4)) / 2: PRINT MSG$(4)
OUT DP, 1                                                '*** Turns NCO clock ON
      END IF
      IF ASC(RIGHT$(K$, 1)) = 68 THEN GOTO endp          '*** [F6]
END IF
LOOP
endp: COLOR 7, 0: CLS
END                'xxxx END PROGRAM xxxxx END PROGRAM xxxxx END PROGPAM
'---------------------------------------------------------------------------
```

emitter-follower (Q1 and Q2), and C8. The final RC section consists of R10, R11, and C4. With the values shown in Fig. 1, the NCO generates a relatively constant 5-volt peak-to-peak signal into an open circuit from 0.1 hertz to 5 megahertz. At 10 megahertz, the output amplitude is down to 3 volts peak-to-peak.

The impedance seen looking into the joined emitters of the two transistors (Q1 and Q2) that make up the simple complimentary emitter-follower output driver is about 11 ohms. The 39-ohm resistor (R17) in series with the output terminal sets the output impedance seen by the load to 50 ohms.

Two operating voltages are required for this circuit to work: +5 volts and −5 volts. Both voltages are derived from a 9-volt AC-to-DC adapter. The +5 volts is supplied by an LM7805 voltage-regulator. A National Semiconductor LM2574 switching regulator generates the −5 volts. Diode D4 in series with the regulators protects the board against accidental power-supply reversals. The +5-volt supply must provide about 200 milliamperes, so the LM7805 should be fitted with a heat sink.

The 32-megahertz oscillator could have been built with discrete components for a few dollars less than the clock module IC4 that is specified. However, 32-megahertz oscillators can be cranky at times, and they tend to be noisy. By contrast, the module specified is small and quite reliable.

Programming

The PC must manipulate four control lines for the PSG to work. The CLOCK line is a PC-simulated shift clock for moving data (on the DATA line) into the NCO buffer. The FLOAD line transfers data from the NCO's input buffer to its active registers, and the ON/OFF line turns the PSG output on and off. The four control lines correspond to the first four lines of the parallel port data register as shown in Table 1.

To program the PSG, first

regulator (National Semiconductoror equivalent)
D1–D4—1N4148 diode
D5—1N4001 diode
D6—1N4933 fast rectifier diode (Motorola or equivalent)
Q1—2N4401 NPN transistor
Q2—2N4403 PNP transistor

Other components
J1—male DB-25 jack
J2, J3—BNC jack
L1—390 µH choke (Renco No. RL3901 or equivalent)

Miscellaneous: Four-foot length of five-conductor cable, four hex spacers and screws (for PC-board "feet"), clip-on heat sink for TO-220 case, PC board, 9-volt DC adapter, solder.

Note: The following items are available from R.J. Portugal, 52 Susan Lane, North Haven, CT 06473:
- **PC board—$20.00**
- **Parts kit including the PC board board-mounted components (does not include any of the "Miscellaneous" parts listed above or jacks J1–J3)—$64.95**
- **5.25-inch, 1.2 Meg floppy diskette containing QBASIC source program—$12.00**

Please add $3.50 for S&H on continental USA orders. All others add $5.00. Make checks or postal money orders payable to R.J. Portugal.

```
SUB DSPLY
COLOR 15, 10: LOCATE 2, 40 - LEN(MSG$(8)) / 2: PRINT MSG$(8)
COLOR 15, 1: LOCATE 5, 1
PRINT "        [F1]        Enter Frequency 1                           Hz"
PRINT "                    (0.00 to 10,000,000.00Hz                    usec"
PRINT
PRINT "        [F2]        Enter Frequency 2                           Hz"
PRINT "                    (0.00 to 10,000,000.00Hz                    usec"
PRINT
PRINT "        [F3]        Clear Frequency 1 and 2 to zero": LOCATE 19, 1
PRINT "        [F4]  Load NCO                        [F5]  Start/Stop PSG output"
PRINT
PRINT "                              [F10]   End program-return to DOS"
COLOR 15, 10
LOCATE 23, 40 - (LEN(MSG$(9)) + LEN(MSG$(10))) / 2: PRINT MSG$(9) + MSG$(10)
COLOR 7, 9: LOCATE 25, 40 - LEN(MSG$(11)) / 2: PRINT MSG$(11); : COLOR 15, 1
END SUB

SUB ERMSG (L1, L2)                    '*** Displays 2 line error message
CALL FREQCLR(L1, L2)
COLOR 14, 4:  FOR i = 14 TO 15:      LOCATE i, 9: PRINT MSG$(i - 13); : NEXT i
SLEEP 4: COLOR 15, 1: FOR i = 14 TO 16: LOCATE i, 9: PRINT MSG$(3); NEXT i
END SUB

SUB FREQCLR (L1, L2)           '*** Clears control panel F1 & F2 display areas
COLOR 14, 4: LOCATE L1, 45: PRINT MSG$(4): LOCATE L2, 45: PRINT MSG$(4)
END SUB

SUB FREQUENCY (L1, L2, flg)                  '*** F1 & F2 input routine
COLOR 14, 4: CALL FREQCLR(L1, L2): LOCATE L1, 45: LINE INPUT f$
IF VAL(f$) > 10000000 OR VAL(f$) < 0 THEN CALL ERMSG(L1, L2): GOTO esub
dpf = 0
    FOR i = 1 TO LEN(f$)          '*** F1/2 numeral & multiple decimal point
    x$ = MID$(f$, i, 1)           '*** check
     IF x$ = "." AND dpf = 0 THEN : dpf = 1: GOTO x
     IF x$ = "." AND dpf = 1 THEN CALL ERMSG(L1, L2): GOTO esub
     IF ASC(x$) < 48 OR ASC(x$) > 57 THEN CALL ERMSG(L1, L2): GOTO esub
x:  NEXT i
    f = VAL(f$): LOCATE L1, 45: PRINT USING FMT$; f;  '*** prints freq
LOCATE L2, 45
IF f <> 0 THEN PRINT USING FMT$; 1000000 / f;        '*** period of F1 or F2
IF flg = 1 THEN N1& = K * f              '*** Converts F1 or F2 to a 32bit word
IF flg = 2 THEN N2& = K * f              '*** compatible with NCO input specs
COLOR 22, 7: LOCATE 16, 40 - LEN(MSG$(5)) / 2: PRINT MSG$(5): COLOR 15, 1
esub:
END SUB

SUB LOAD      '*** Converts F1&2 into serial format & shifts them into NCO
FOR j = 3 TO 0 STEP -1: FOR x = 7 TO 0 STEP -1    '***** Xfer first 32 bits
     IF (PEEK(VARPTR(N2&) + j) AND 2 ^ x) > 0 THEN dt = 2 ELSE dt = 0
OUT DP, dt + 4: OUT DP, 1 + dt + 4          '*** Serial data and shift
NEXT x: NEXT j                              '*** pulse generator
FOR j = 3 TO 0 STEP -1: FOR x = 7 TO 0 STEP -1    '***** Xfer second 32 bits
     IF (PEEK(VARPTR(N1&) + j) AND 2 ^ x) > 0 THEN dt = 2 ELSE dt = 0
OUT DP, dt + 4 + 16: OUT DP, 1 + dt + 4 + 16      '*** Serial data and shift
NEXT x: NEXT j                                    '*** pulse generator
     OUT DP, 1 + 16                               '*** Xfers new F1&2 to NCO
COLOR 15, 1
LOCATE 16, 10: PRINT MSG$(6)
END SUB
```

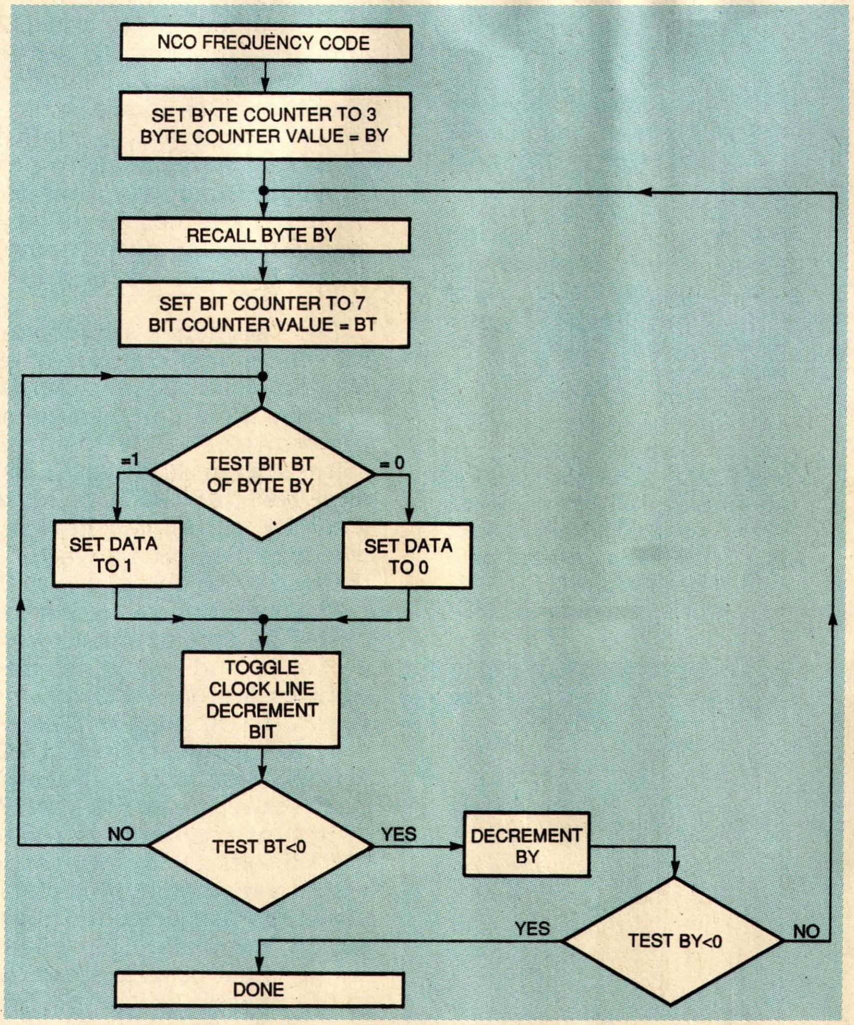


FIG. 2—PARTIAL SUBROUTINE FLOWCHART. The 32-bit NCO frequency code must be read into the board bit-by-bit.

specify some output frequency. Enter that frequency with an input statement (assuming a program written in QBASIC) and then convert the frequency to the format that the NCO wants to see by using the following equation:

N = Integer Portion ($f_{OUT} \times 2^{32}/f_{CLK}$)

where: N = NCO code number, f_{OUT} = The output frequency, and f_{CLK} = 32 MHz.

The integer portion of the equation means that only the digits to the left of the decimal point are used for N. Using Basic's long-integer suffix ensures that the NCO frequency code number (N) will be stored in a 32-bit format. An "&" following a variable declares it a long-integer which happens to be 32 bits long.

The program for the PSG shown in Listing 1 is written in QBASIC version 4.5. The program has a few nice features such as: parallel-port selection (LPT1, LPT2, or LPT3), a multicolor display, error messages, and user prompts. The program has been tested on both a 386-based IBM-compatible PC and an old monochrome 8088-based PC running at 4.77 megahertz, and it performs equally well on both machines.

This article will not include a line-by-line analysis of the program. However, consider the "sub load" subroutine. This is where the NCO data word is converted from parallel to serial format and sent to the NCO board. The easiest way to understand what's going on here is to study Fig. 2, a partial flowchart of the subroutine.

First the 32-bit NCO frequency code must be read into the board bit-by-bit. The board is set up for most-significant-bit first entry of the serial data (bit 32 goes to the NCO first and bit 0 is sent last). Next, long-integers in QBASIC are stored as groups of four successive bytes in the PC's memory, least-significant-byte first, most-significant-byte last. Once the memory location of N is known, N must be read in reverse order, fourth byte to first byte. The "Set byte count to 3" and "Decrement BY" lines keep track of which byte is being processed.

The byte now must be scanned from the top down; that is, the most-significant-bit to the least-significant-bit. This is where the "Set bit counter to 7," "Test bit BT," "Set DATA to 1 or 0," "Toggle Clock Decrement BT," and "TEST BT" blocks are used. The program looks at each bit of N, MSB first, and then decides whether the bit is a one or a zero. It then sets the DATA line and toggles the CLOCK line, sending the DATA bit to the NCO.

After each pass through the inside loop (the bit test loop), the bit counter content (BT) is tested to see if all the bits have been scanned—if not, the loop is completed again. When a bit scan has been completed, the BY counter is adjusted and tested to see if the last byte has been processed. Again, the program loops until all bytes have been processed.

With the powerful instructions available in QBASIC, the whole procedure can be completed with just a few lines of code:

```
FOR J = 3 TO 0 STEP-1
FOR X = 7 TO 0 STEP-1
IF PEEK (VARPTR (N&) + J)
AND 2^X > 0 THEN dt = 2 ELSE
   dt = 0
OUT dp, 0 + dt + 4 : OUT dp, 1
   + dt + 4 NEXT J
NEXT X
```

The "IF PEEK..." line is fairly complex. The FOR NEXT J loop accounts for the bytes and the FOR NEXT X loop handles the bit tracking. Starting from the inside and working out, the VARPTR(N&) function returns the address of the variable N&.

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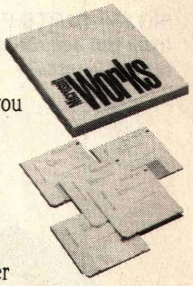

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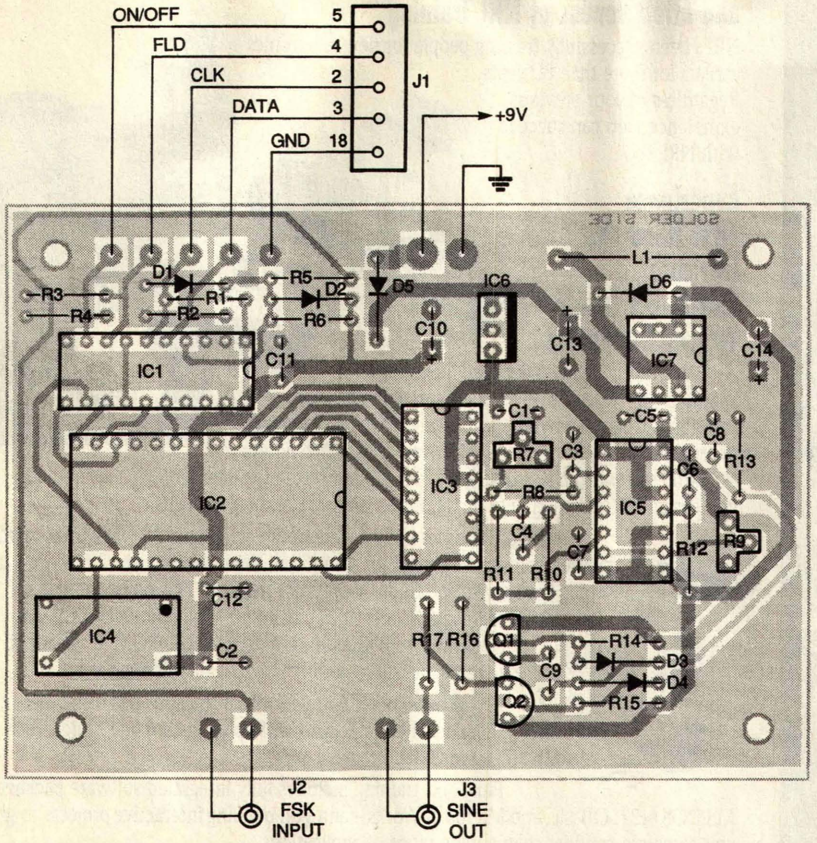


FIG. 3—PARTS-PLACEMENT DIAGRAM. You can make your own board or buy one from the source given in the Parts List. The input/output connectors are not mounted on the board.

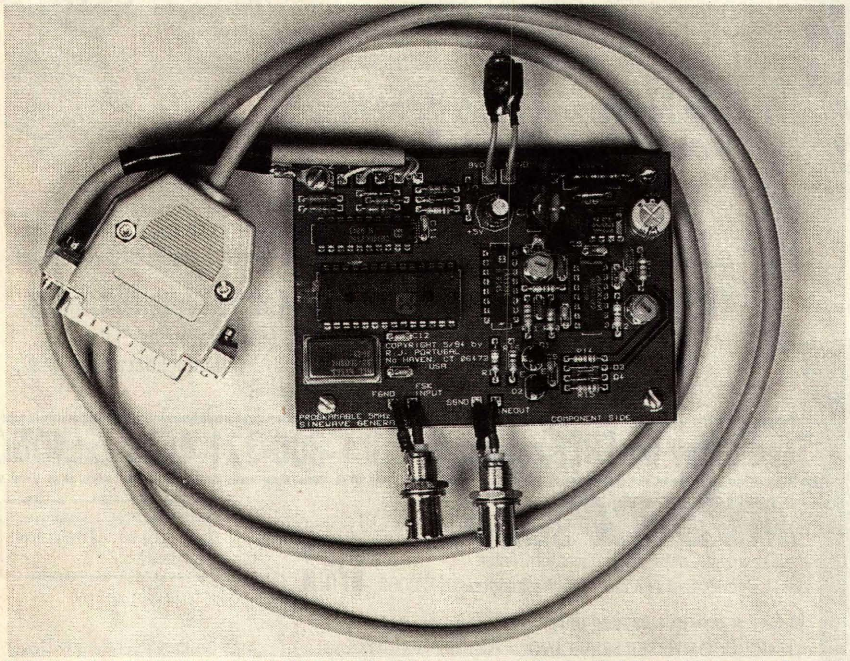


FIG. 4—AN EARLY PSG PROTOTYPE. This board differs slightly in its parts layout from the final design.

that is the address of the first byte of N& (remember that N& consists of four memory bytes). PEEK returns the value of the data byte stored at the specified memory location. So, VARPTR(N&) provides the address of the first byte of N&, and PEEK reads the value of the byte at the address. The "J" inside the PEEK function selects one of the four N& bytes.

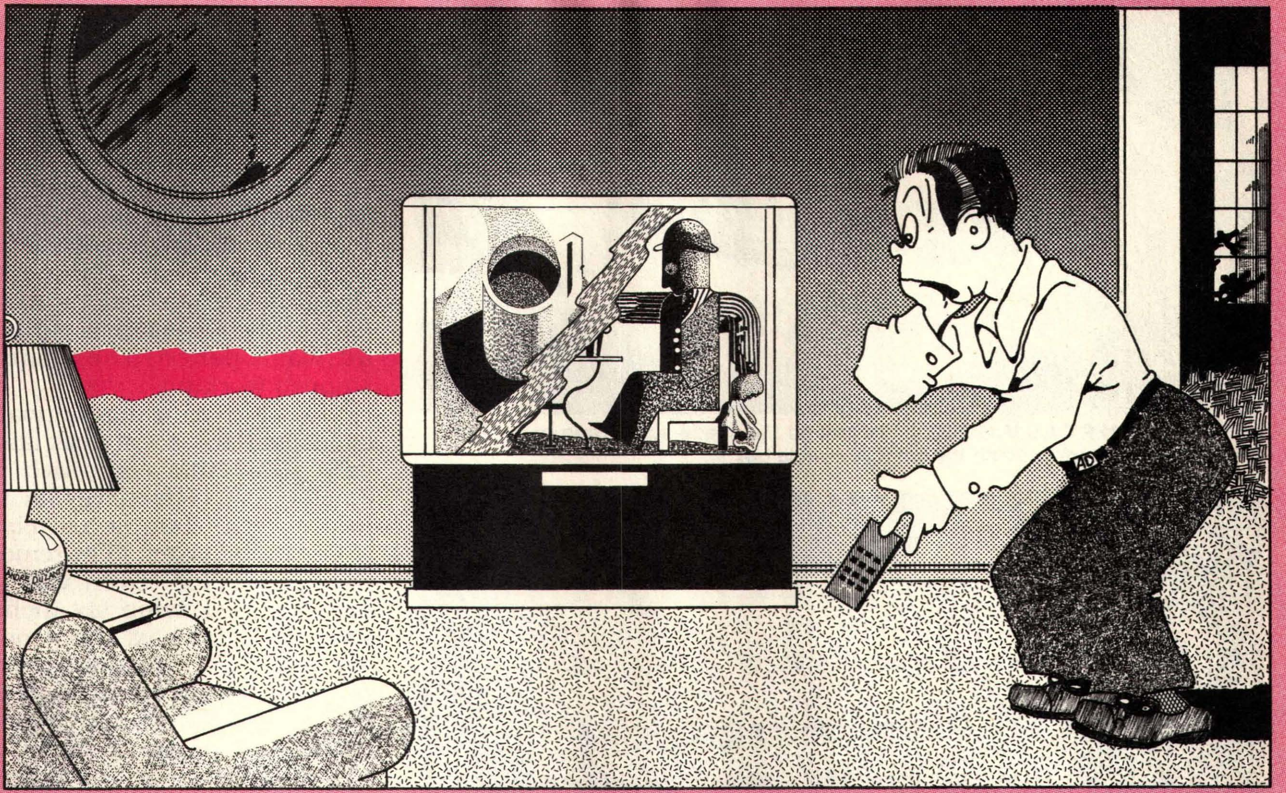
The AND logical operator creates the logical results of ANDing two quantities, in this case the eight-bit word supplied by the VARPTR and the eight-bit equivalent of 2^X. Since 2^X takeson binary values only (0, 1, 2, 4, 8, 16, 32, 64 and 128), only one bit of binary word equivalent to 2^X is a high for each value of X. When two bits are ANDed, the result is a one when both bits are ones. If the N& byte being scanned has a one as its MSB, and it is ANDed with 2^7, the result of the AND function will be a binary word equivalent to decimal 128. If the MSB is zero, the resulting word will be zero. This process is called "masking" and it should be familiar to anyone experienced with C or machine-language programming. As the value of X changes from 7 to 0, each bit of the current byte is tested by the AND function.

The final part of the program line, THEN, sets variable dt to either a 2 or a 0. Refer to Table 1. Data to be fed to the NCO appears as the second bit of the parallel-port data word, and it has a binary weight of 2.

The two OUT instructions send bytes to the parallel port data register (dp). The first OUT instruction sends the results of the bit analysis (0 or 2) plus 4 to the NCO. The "4" (refer to Table 1) controls the NCO's FLOAD input that should be set high when data is being transferred to the chip. The second OUT instruction is identical to the first OUT instruction except for an additional "1." That "1" turns on the NCO CLOCK input, producing a positive edge that shifts the value into the NCO.

You might have to read the preceding paragraphs several times so that you understand how the load subroutine works. Once you understood the procedure, you can program the NCO board to do anything it's capable of doing. The rest of the program provides visual enhancements to the screen display, and generally forms a clean control panel for the PSG.

(Continued on page 66)



PHANTOM OF THE ETHER

The new energy-saving fluorescent bulbs save money on electric bills, but they can interfere with infrared remote controls.

TOM HEALD

I WAS WATCHING A MOVIE ON A CABLE channel one night when suddenly my TV set jumped channels. I grabbed my universal infrared remote control and tried to switch back to the channel I was watching but nothing happened. The remote was dead! So I went to my cable box and changed the channel back to the program I was watching. However, a few minutes later the channel switched again. What was going on? Nobody else had been near either my remote control or cable box.

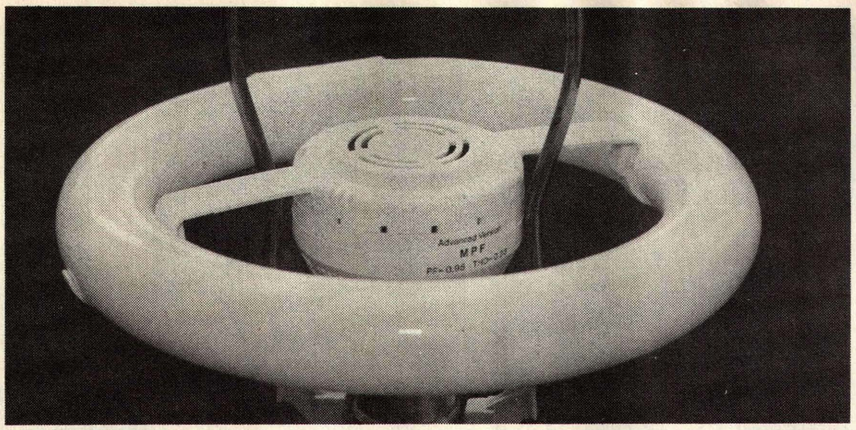
I then pointed my remote control at my TV set, reset the channel, adjusted the volume and tested the mute. All three functions worked. Five minutes later the TV screen bloomed into a field of snow, and the hiss of static overcame the audio. The cable box had turned itself off.

The next day the remote control worked fine with the TV and VCR but not with the cable box. I called my local cable company and asked if it was experiencing technical difficulties. A spokesman for the cable company declared "No, it's those universal remotes. They're always causing problems with our boxes. If you rent one of our remotes, it'll work just fine."

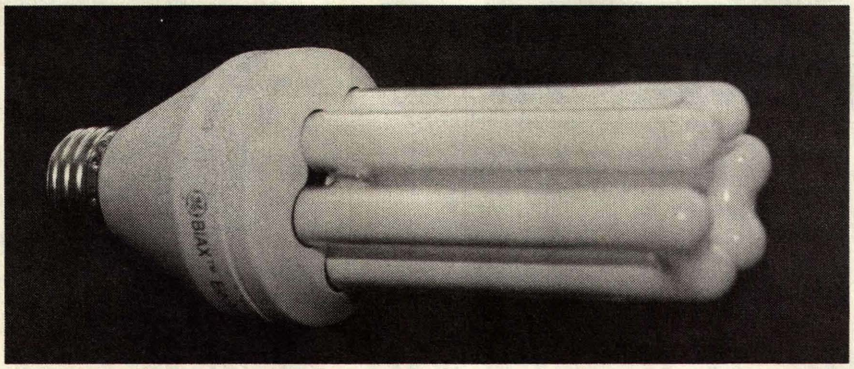
Rather than follow this suggestion, I returned my cable box and swapped it for a new one, thinking that the problem would be solved. The replacement box worked just fine, but a few days later the remote control started acting up again.

Mystified, I called Universal Electronics, makers of my One For All remote control, and explained my problem. The customer service representative said he had not heard about my spontaneous switching problem before, but he suggested that the cause could be in the code for my cable box. I was given a special code to reset my remote control, and then I tried all the codes for my Scientific Atlanta cable box. Everything worked well for a couple of hours before the glitch finally returned.

I thought about probable causes and over the next few day I carried out a concerted attack on the mystery. First, I bought new batteries for my remote control, then I rented a dedicated remote control from the cable company. Finally, in desperation, I exchanged the cable box again and bought a brand new remote control.



LIGHTS OF AMERICA's Model 2022 fits around the shade supporting harp of most table lamps. It interfered with the authors's cable box.



GENERAL ELECTRIC'S Model 1302 did not interrupt any of the author's entertainment electronics.

Everything worked well during the day, but at night neither my new universal remote control nor cable-box remote would work. I then concluded that the cause might be noise on the cable—or perhaps some energy source interfering with my remote's signal. Although I felt foolish doing it, I turned off all the lights in my house and, with my remote, switched a number of channels. Had the problem been solved?

Then I turned the lights back on, one at a time, and eventually narrowed down the offending source to new energy-saving fluorescent tubes that I had installed months earlier. These bulbs were interfering with my remote control, but the standard fluorescent tubes in my kitchen lighting fixture had no effect on it.

I ruled out power consumption as a cause: the energy-saving fluorescent tubes were rated for 30 watts, but the kitchen fixture contained four 40-watt tubes. It seemed that the fluorescent bulbs were producing an infrared signal that jammed my cable box and, on occasion, simulated the remote control's signal.

I phoned several fluorescent lamp manufacturers to see if they could shed some light on this interference. "Yes, we have had some complaints," said Scott Mack, a spokesman for Philips Lighting. He advised me to make sure the energy-saving bulbs were at least 10 feet away from my TV set and cable box and that they were plugged into different household electrical circuits.

"But that's the cure for radio frequency interference," I protested, "what about infrared interference?" He agreed with me, but said that until Philips came up with a definitive solution this was the suggested response to any complaints. "In fact," he added "If those suggestions don't work, try moving the energy-saving lamps to a different room."

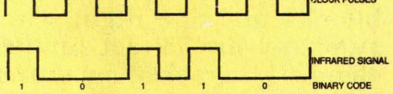
Ghost busting

I connected the lamp with the fluorescent bulb to a different electrical circuit with an extension cord, and I moved it 16 feet away from the cable box—but that didn't help. To prove to myself that it was infrared energy emitted from the bulb and not RFI on the line, I put the lamp in a large cardboard box. With the lamp turned on inside the closed box, there was no interference. But as soon as the box lid was opened, the remote stopped working.

Next, I tried a magnetically ballasted fluorescent desk lamp with an circular eight-inch diameter tube. (The energy saving fluorescents lamps are electronically ballasted.) The remote was unaffected. Even when I held the desk lamp six inches from the cable box, the remote worked. First I assumed that the desk lamp's tube produced a more natural "daylight" spectrum, and perhaps that was why it differed from the fluorescent bulbs.

HOW DOES YOUR REMOTE CONTROL WORK?

Modern remote controls apply many different techniques to communicate with TVs, VCRs, and other consumer electronic products. Their coded signals might vary, but all remote control circuits are basically the same. Most transmit pulses of infrared energy at a specific frequency (e.g., 56 kilohertz). Each time a key is pressed, a group of coded pulses is generated.



A typical code contains 24 bits of binary information. The first four bits determine which one of 16 possible products is to be controlled. For example, 0 is for the TV receiver, 1 is for the first VCR, 2 is for the second VCR, and 3 for a compact disk player. The next eight bits in the sequence identify the key that has been pressed. Those eight bits permit a total of 256 possible key codes. The last 12 bits are check bits which are compared with the first 12 bits to detect errors.

When the receiver within the host product detects an infrared signal, it compares it with a clock pulse operating at the same frequency. If the signal is high, a binary one is generated; otherwise, a zero is generated. After the message is decoded the host equipment is commanded to respond. Ω

VISIBLE LIGHT SPECTRUM

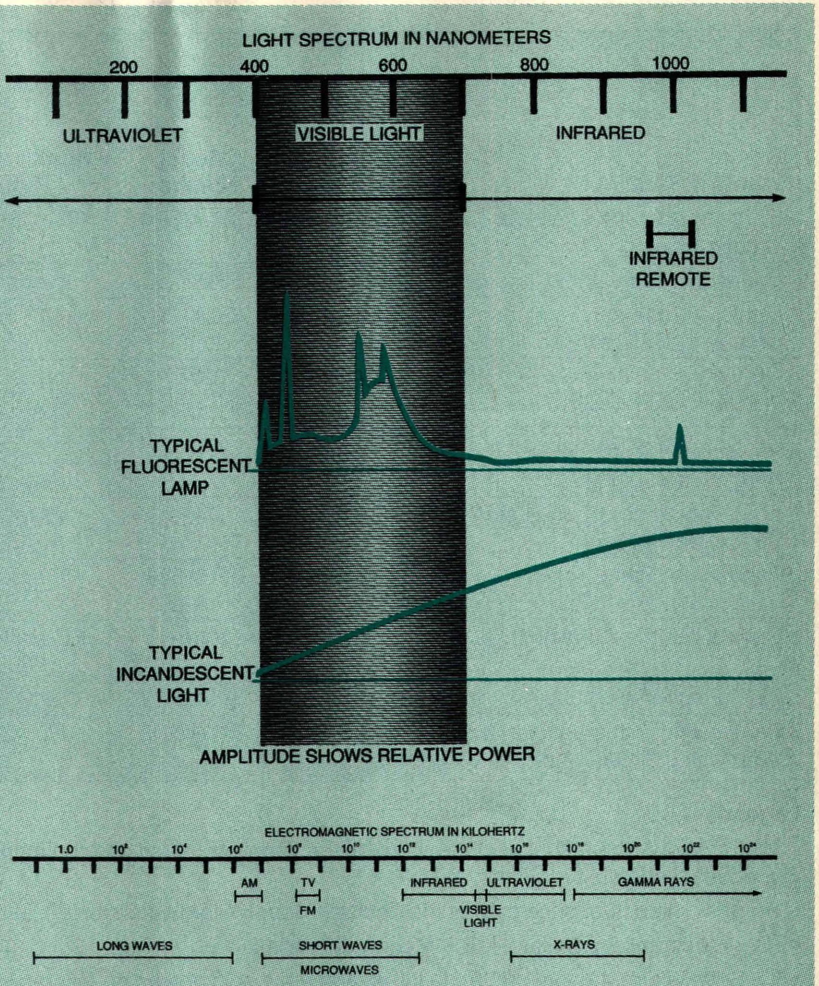
Visible light occupies only a small part of the electromagnetic spectrum. It is generally considered to span the range of wavelengths from 380 nanometers (violet light) to over 700 nanometers (red light). These limits are also be expressed as 0.38 to 0.70 micrometers.

Infrared remote controls based on readily available infrared-emitting LEDs (IREDs) emit at wavelengths of about 1000 nanometers (1 micrometer) in the near infrared region.

The light emission specectrum from a fluorescent tubes depends on the phosphor coating inside the tube. About 90 % of its energy is converted to light with the remaining 10 % dissipated as heat (infrared) radiation. The light spectrum illustrated is for one of the most common "white" fluorescent lamps that emit a more natural light than earlier tubes. The fluorescent spectral distribution curve closely brackets the visible light spectrum.

An incandescent bulb, by contrast, is only about 10 % efficient. Most of the remaining 90 % of the energy is dissipated as heat in the near infrared region. Its spectral distribution extends beyond 2800 nanometers.

It's not the intensity of infrared radiation that interferes with remote controls. It's the frequency of the modulating signal applied to the neon tube. Electronically ballasted fluorescent lamps can overwhelm a remote control by producing a stronger signal "tuned" to the infrared receiver circuit's frequency.



This assumption turned out to be faulty: I then guessed that the interference had something to do with the way the electronically ballasted lamp worked.

"Compact fluorescent tubes operate at high-frequencies," explained Arnold Buddenbery, a researcher at the Lighting Research Center of Rensselaer Polytechnic Institute in Troy, NY. He said those high frequencies modulate the tube's infrared output and cause interference for remote controls based on infrared emission.

The heavy magnetic ballast associated with standard fluorescent tubes limits the flow of 60-hertz current through the tube. That ballast produces a flicker that can be annoying in rooms lit by the older fluorescent lights. Their flicker rate is 120 hertz, twice that of line power.

The operating frequency of electronically ballasted fluorescent lights is between 25 and 50 kilohertz. They produce a 50- to 100-kilohertz flicker, which is too fast for human eyes to sense. However, it is this nonvisible flicker in the form of a switched infrared signal that interferes with infrared remote controls. The remote controls for switching cable boxes, TV sets, VCRs, and stereos also switch in the 50- to 100-kilohertz range to transmit binary data to receiving circuits built into those products.

"We woke up one morning and our sets didn't work," reports Don Lowry, Matsushita Electronics' director of engineering. "Each case is a little bit different, but our countermeasures have been effective in managing all of them."

The latest infrared receiver circuits in consumer electronic products include automatic gain control (AGC) and a clocking circuit that isolates the remote-control signal from spurious infrared radiation. Some circuits look at the signal's center frequency and pulse width and reject all infrared transients that are shorter than valid code signals.

In addition, the latest products have better infrared shielding that limits the view from the infrared receiver to a narrow cone of energy incident at the front of the host equipment.

"We're trying to find an infrared interference prevention scheme that will be acceptable to all manufacturers," reported Tom Mock, speaking for the Electronics Industries Association (EIA) in Washington, DC. Its Consumer Electronics Group includes representatives of lighting and consumer electronics manufacturers.

TABLE 1

Lights Tested	Watts: Rating / Replaces	Model Number	Replacement Tube	Price	Type	CABLE	VCR	STEREO	TV 1	TV 2
Lights of America eight inch circular tube.	30 / 115	C2030TP-L	FCL30EX-L	14.99	EB	S		I		
Panasonic Twin Light Capsule	27 / 100	EFD27LE	Integrated	19.99	EB					
Lights of American eight inch circular tube. (Reduced THD)	22 / 100	2022TP	FC8TEX-L/ RS	12.99	EB	S				
GE Energy Choice	26 / 90	22857	Integrated	9.99	EB					
OSRAM DULUX EL	20 / 75	DULUX EL	Integrated	16.99	EB		I			
GE Soft White (Reduced THD)	20 / 75	11302	Integrated	9.99	EB					
Philips Earth Light	18 / 75	SL*18	Integrated	16.99	EB		S	I		
Abco Table Lamp Conversion Set Electric Saver	16 / 60	7430	13W/27K uE6	19.99	MB					
Panasonic Light Capsule	15 / 60	BFG15LE / A-C	Integrated	14.99	MB					
Light of America Lifelight U-tube	12 / 60	6000-1	FUL12T60W 9308	9.99	MB					
FEIT Electronic U-tube.	9 / 60	BPMLPL9	9W/2700K	12.99	MB					
Dana swing arm magnifier desk lamp with a circular tube.	22 / 75	370WHT	FCL-22D	47.99	MB					

Legend:

- "Watts" shows the actual wattage rating of the fluorescent unit and the manufacturer's approximation of the incandescent bulb it replaces.
- "Price" is the actual price paid at the Orchard Supply Hardware store in Gilroy, CA.
- EB = Electronically Ballast, MB = Maghnetic Ballast.
- S = Solid failure, I = Intermittent failures, and a blank indicates no failures.

Personal computer manufacturers have developed a standard for interconnecting computers and peripherals in networks with infrared signals. It would, for example, permit a printer, to be located anywhere in the room. It would also permit a personal digital assistant (PDA) to download data to a personal computer without a cable connection.

The Consumer Electronics Bus (CEBus) is a multimedia standard for home control. It covers signaling over powerlines, radio frequency and infrared transmission, and coaxial and twisted-pair cabling. The infrared emission frequency is about 100 kilohertz in the near infrared region. Mr. Mock said that so far no problems have been encountered with the energy-saving fluorescent tubes, "but we still have to make sure the tubes don't emit in that frequency range."

What's the payback?

If you consider all of the interfering signals that these energy-saving fluorescent lights transmit, why should you consider buying them? The answer is to save money on electric bills. All fluorescent lighting saves money over equivalent incandescent lighting because it produces light more efficiently.

A fluorescent tube costs 60 to 75% less to operate than an equivalent incandescent bulb, and it has a life that is about ten times longer. Also, with higher efficiency lighting, less heat is dissipated in the room—especially important in air-conditioned rooms.

A typical 100-watt incandescent bulb costs about 90 cents and lasts 750 hours. By contrast, a 22-watt compact fluorescent tube will last 10,000 hours while giving an equivalent amount of light. For starters, you can buy a compact fluorescent tube for less then $12—the cost of 13 replacement incandescent bulbs.

If your average lighting usage is three hours a day, and you pay a typical rate of 8.5 cents per kilowatt-hour, you will save $7.26 per year on each light tube. At the very high New York City utility rate of 20 cents per kilowatt-hour, you'll save $17.08. At that rate, each fluorescent light will save you $154 over its nine-year life.

Testing the lamps

To see how pervasive interference is, I tested a number of consumer electronics products in the presence of 12 fluorescent lights made by eight different manufacturers. With the exception of a swing-arm desk lamp/ magnifier, all the compact fluorescent lamps had threaded bases that screw into standard incandescent lamp sockets.

Electronic ballasts are light in

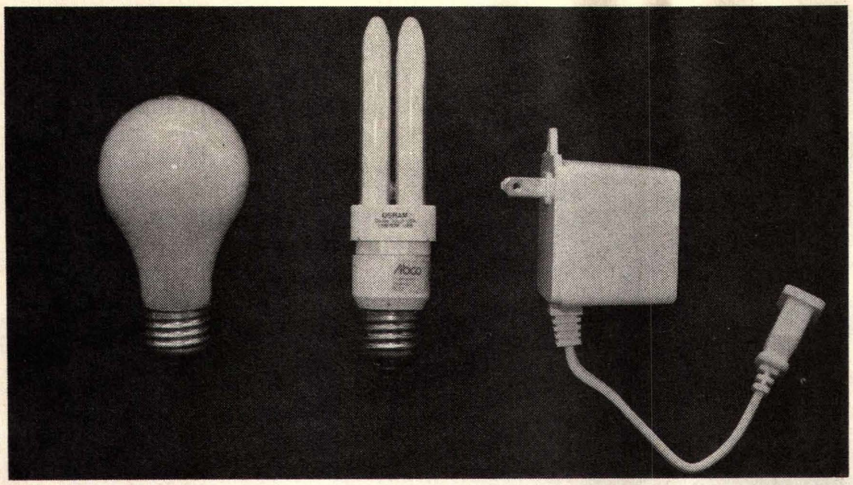


TABLE LAMPS WITH ABCO FLUORESCENT tubes are lighter and more stable because the heavy magnetic ballast is located at the wall outlet. It is as bright as the 60-watt incandescent bulb.

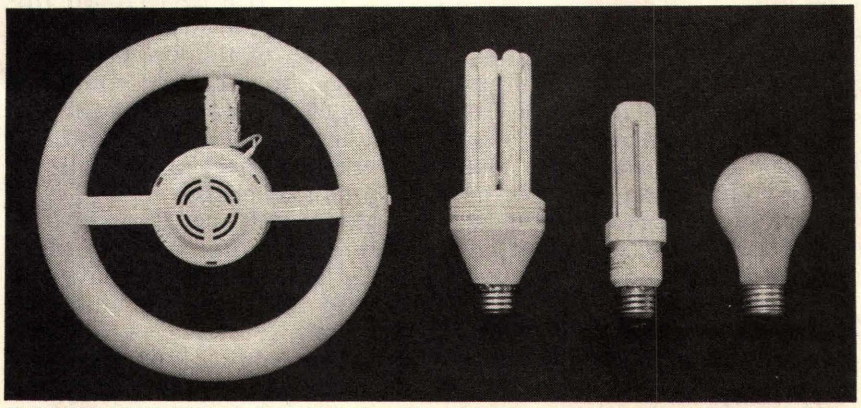
weight and start the associated fluorescent lamp instantly, but, as has been pointed out, they can interfere with infrared remote controls. However, if you consider the many different fluorescent-lamp operating frequencies and the differences between the brands of infrared receiver circuits in the host entertainment products, you quickly realize that there is no way to predict which combination will cause interference problems.

Bulky magnetic fluorescent tube ballasts might weigh more than ten ounces, so they can make a table lamp top-heavy. Moreover, these lights flicker for a few moments when turned on, and some might hum. But they don't interfere with your infrared remote control, and they also save on your electric bill.

I made my tests on popular consumer electronics products: a Scientific Atlanta 8500321 cable converter, Mitsubishi CS-2655R and Toshiba CE2058 TV receivers, and an RCA VR680HF VCR. I tested all three products with their original equipment remote controls as well as the universal URC-2085 from Universal Electronics.

I went on to test three Technics products: an SA-R277 stereo receiver, a CL-PC10 CD player, and a SR-TR155 dual-cassette tape deck. One original equipment remote control operates all of those components.

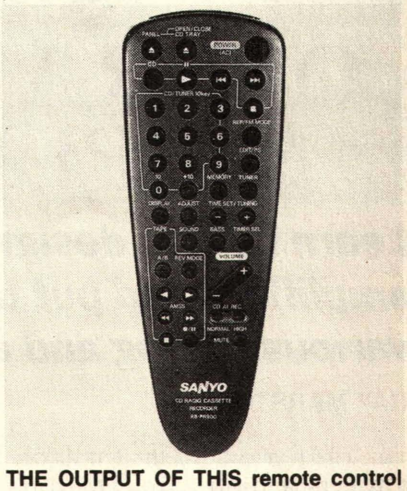
I encountered six instances of infrared interference, as shown in the last five columns of Table 1. As expected, only the electronically ballasted fluorescent tubes caused interference. I believe continuous interference is caused only when the ballast frequency is half that of the infrared remote control's modulation frequency.



FLUORESCENT TUBES COMPARED with a 60-watt incandescent lamp are LOA's 22/100-watt circular, GE's 20/75-watt, and Abco's 16/60-watt tubes.

My test results suggest that intermittent interference is more likely to be caused by harmonic frequencies in the infrared region. This is supported by my test of the two eight-inch circular fluorescent lamps. The reduced total harmonic distortion version did not interfere with the stereo; however, both lamps interrupted the cable box.

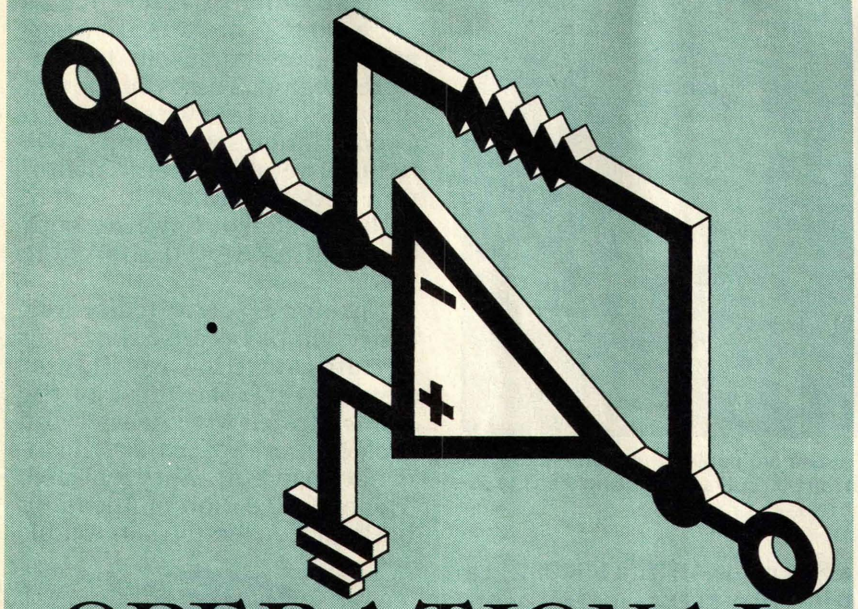
I prefer electronically ballasted lamps because they offer instant starting and lighter weight. However, most of the tubes I tested were heavier and took up more space than the incandescent bulbs they replaced. The one exception is Abco's table lamp conversion set. A table lamp with this tube is not top-heavy because the ballast is located in a small box that plugs into a power line wall outlet. It has a socket for the lamp's line cord.



THE OUTPUT OF THIS remote control was "swamped" by an energy-efficient fluorescent tube.

This arrangement permits a circuler, compact fluorescent light to fit easily around the lamp's shade-supporting "harp" which is too small to accommodate most of the other energy-saving fluorescent tubes with screw-type bases.

If you decide to buy an electronically ballasted lamp, look for one that has a label stating that it has reduced total harmonic distortion. It will produce far fewer annoying frequencies. My favorites are a 22-watt tube from Lights of America and a 20-watt tube from General Electric. Ω



OPERATIONAL AMPLIFIERS

Learn how to design with operational amplifiers and put them to work in various analog and audio circuits

RAY MARSTON

THE OPERATIONAL AMPLIFIER (OP-amp) is a high-gain, DC-coupled amplifier with a differential input (two input leads) and a single-ended output (one output lead). It is one of the most versatile circuits ever invented because it closely approximates the ideal amplifier.

The versatility of the op-amp has made it a key functional building block in linear or analog circuitry because it eliminates the need for bulky transformers in many low-frequency and audio circuits. This article will focus on the role of the op-amp in performing audio signal processing.

The op-amp was developed more than 40 years ago to perform mathematical operations such as addition, subtraction, integration, and differentiation in analog computers. Originally a vacuum-tube, DC-amplifier circuit, it evolved into a discrete transistor circuit before being made as a monolithic integrated circuit.

The availability of mass-produced, low-cost, monolithic op-amps has had a significant impact on all linear circuitry. Op-amps are included in both discrete and monolithic circuits for signal conditioning, power regulation, active filtering, function generation, digital-to-analog conversion, and many other applications.

Ideal amplifier

An op-amp has many of the characteristics of an ideal amplifier. It will be instructive to review the characteristics of an ideal amplifier and then compare them with the performance characteristics of existing monolithic IC op-amps. The characteristics of the ideal amplifier are:

Gain. An ideal amplifier would have infinite gain. However, this is not desirable in a practical amplifier because the smallest input signal would cause maximum output. Thus, high but controllable gain is acceptable.

Input impedance. An ideal amplifier would have infinite input impedance or resistance so its input source would not be incorrectly loaded.

Output impedance. An ideal amplifier would have zero output impedance or resistance so that it could be connected to a load with any resistance value without affecting its output voltage.

Bandwidth. An ideal amplifier would have infinite bandwidth so that it could amplify any frequency from zero hertz (DC) to the upper limits of the radio-frequency spectrum.

Common-mode rejection ratio. An ideal amplifier would have an infinite common-mode rejection ratio or CMMR. This means that if the amplifier has two input terminals (one positive and the other negative), there will be no output if both inputs (common mode) receive the same signal simultaneously. The output of an amplifier that exhibits high CMMR is essentially a zero output if the same signal is applied simultaneously to both of its inputs.

Supply voltage. An ideal amplifier would be unaffected by reasonable variations in power supply voltage.

Practical monolithic op-amps

The 741 is a mature, popular, general-purpose monolithic IC operational amplifier. A bipolar device, it was developed more than 25 years ago by Fairchild Semiconductor Corp. (acquired by National Semiconductor Corp.) as the µA741, an improved version of its µA709. It has retained its popularity and become an industry standard. The µA741 had internal frequency compensation and full overload protection on both its inputs and output.

Many different manufacturers make their own brands of the µA741 and some have improved the performance of the original. Nevertheless, all have similar electrical characteristics. Among the alternate-sourced 741s are four versions from Analog Devices, four from

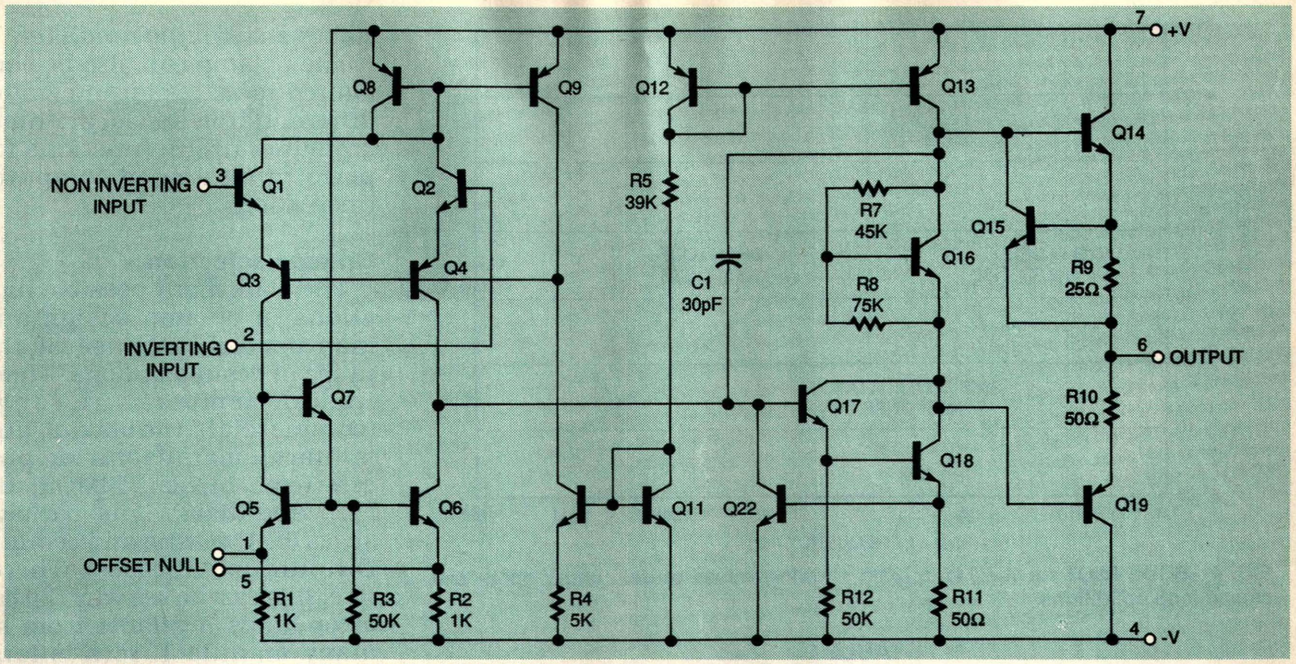

7
+V
Q8
Q9
Q12
Q13
Q14
NON INVERTING INPUT
3
Q1
Q2
R5
39K
R7
45K
Q15
Q16
Q3
Q4
C1
30pF
R8
75K
R9
25Ω
INVERTING INPUT
2
6
OUTPUT
Q7
Q17
R10
50Ω
Q18
Q5
Q6
Q11
Q22
Q19
OFFSET NULL
1
5
R1
1K
R3
50K
R2
1K
R4
5K
R12
50K
R11
50Ω
4
-V

FIG. 1—SCHEMATIC AND CONNECTION DIAGRAM for the industry-standard 741 operational amplifier.

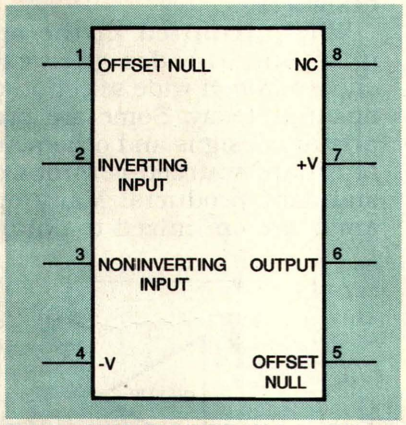

1
OFFSET NULL
NC
8
2
INVERTING INPUT
+V
7
3
NONINVERTING INPUT
OUTPUT
6
4
-V
OFFSET NULL
5

FIG. 2—PINOUT DIAGRAM for a 741 operation amplifier in an eight 8-pin plastic DIP package.

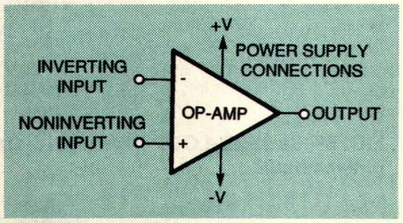

+V
POWER SUPPLY CONNECTIONS
INVERTING INPUT
-
OP-AMP
OUTPUT
NONINVERTING INPUT
+
-V

FIG. 3—SCHEMATIC SYMBOL for a 741 op-amp.

Harris, nine from Maxim, eight from National Semiconductor, three from Philips, and nine from SGS-Thomson.

Because op-amps from all of these suppliers have essentially the same characteristics, the μA741 will be referred to by the generic designation "741" for the remainder of this article. Far from being a leading-edge device, the 741 is, nevertheless, well suited for experiments and prototyping because of its low price and ready availability.

A "commodity" 741 can be purchased from electronic distributors for less than 50 cents, and that unit price falls significantly in large purchases of hundreds.

Some of the typical electrical characteristics of the 741 are given in the first column of Table 1. Many op-amps now in production have characteristics that surpass those of the 741, but they generally cost more. The performance of the two other op-amps included in the table will be discussed later in this article.

Figure 1 is the schematic for the 741 illustrating its complexity. (This contains 19 transistors, but in other versions diodes have replaced two transistors.) Figure 2 is the pinout diagram for the commodity 741 in an eight-pin plastic DIP case. Figure 3 is the standard schematic symbol for all op-amps, but power supply connections are not always shown.

Many op-amps are powered from split power supplies as shown in Fig. 3. The +V, −V and ground (zero volt) rails permit the op-amp's output to swing on either side of zero volts and be set at zero volts when the differential input voltage is zero. However, some op-amps can be powered from single-ended supplies.

Figure 4 is the frequency response curve or *Bode plot* of a 741 op-amp. The 741 offers low-frequency (below 10 Hz) voltage gain that is greater than 100 dB. However, that gain rolls off at 6 dB per octave (20 dB per decade) at frequencies above 10 Hz. It eventually falls to unity gain (0 dB) at its (f_T) *unity gain transition* or cutoff frequency of 1 MHz.

The Bode plot of Fig. 4 can also represent the latest op-amps, but those devices will tipically have different values of low-frequency gain and cutoff frequency.

Closed-loop amplifiers

The op-amp usually serves as the active device in a feedback circuit. Gain is precisely determined by the negative feedback applied from output to input though the components in the external feedback loop. The values of those components set the gain value. However, the feedback loop effectively cancels the op-amp's open-loop electrical characteristics

Figure 5 shows an op-amp configured as a fixed-gain inverting amplifier. The output is fed back to the input, and voltage

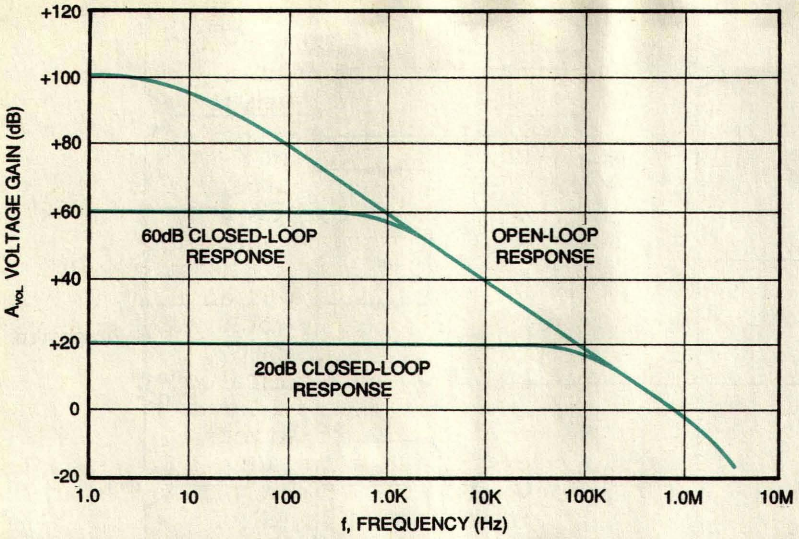


FIG. 4—BODE PLOT for the 741 op-amp showing values of gain under open- and closed-loop conditions.

TABLE 1
TYPICAL ELECTRICAL CHARACTERISTICS OF THREE OP-AMPS

		741	CA3140	LF411	
PARAMETER	**SYMBOL**				**UNITS**
Input offset voltage	Vîo	2	5	0.8	mV
Input offset current	Itô	20 (1)	0.1	25	pA
Input bias current	Iß	80 (1)	2	50	pA
Input resistance	RîN	2×10^6	10×10^{12}	1×10^{12}	Ω
Large-signal voltage gain	AvôL	200	[100K (2)	200	V/mV
Output voltage swing	Vô	±14	----	±13.5	V
Common-mode rejection ratio	CMRR	90	90	100	dB
Supply current	Iŝ	1.7	1.6	1.8	mA
Slew rate	SR	0.5	7	15	V/us
Gain-bandwidth product	GBW	___	3.7	4	MHz
Supply voltage	±18		±15	±18	V
Power dissipation	50		8		mW
(1) nanoamperes	**(2) volts per volt**				

gain A is determined by the ratio of R1 to R2, and equals −R1/R2. This ratio also equals the output voltage divided by the input voltage. This circuit's input impedance equals the value of R1. The circuit can easily be modified to give any desired gain and input impedance values by changing component values.

Current induced at the junction of R2 and R1 is A times greater than that caused by the input signal alone. Therefore, the input acts as if it has an impedance of R2/A connected between the terminal and ground, so it acts like a low-impedance "virtual ground."

Figure 6 shows an op-amp configured as a fixed-gain noninverting AC amplifier. Here the closed-loop voltage gain equals (R1 + R2)/R2 or the output voltage divided by the input voltage. The input impedance approaches infinity.

An op-amp can be made to function as a differential input amplifier by combining the inverting and noninverting connections. If that differential amplifier is modified so that two or more input signals can be added algebraically, the op-amp becomes a *summing amplifier*.

The op-amp can also be configured to act as an integrator, differentiator, and logarithmic amplifier, useful functions for performing analog computer calculations.

Op-amp selection

There are many possible variations in op-amp design and manufacture because of the range of desired options. These include temperature range (commercial, industrial and military), manufacturing process (e.g., bipolar, BiMOS, BiFET, and JFET), and package styles (e.g., plastic and ceramic DIP, and metal cases). Therefore, it is easy to see why the list of op-amps available from so many manufacturers is long and bewildering— even for experienced professional circuit designers.

Where required in the application, the designer can choose from a wide selection of op-amps today. Some are proprietary designs and others are alternate-sourced-versions of standard products. Many op-amps are optimized to obtain

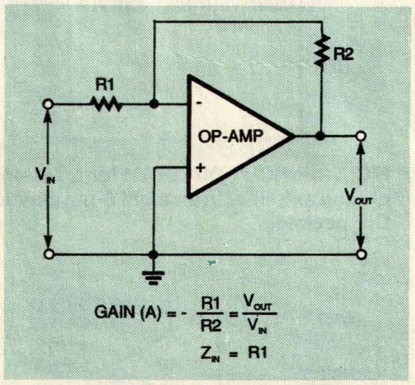


FIG. 5—CLOSED-LOOP INVERTING amplifier circuit.

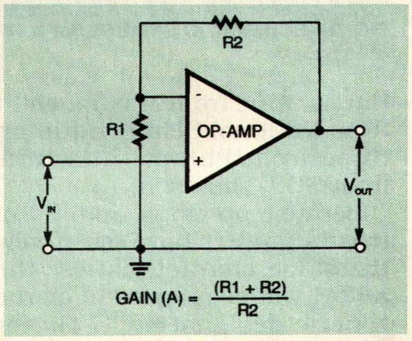


FIG. 6—CLOSED-LOOP NONINVERTING amplifier circuit.

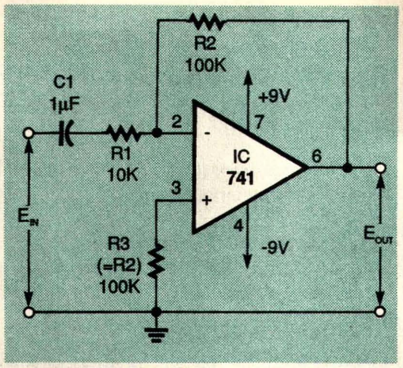


FIG. 7—INVERTING AC AMPLIFIER with a gain of 10.

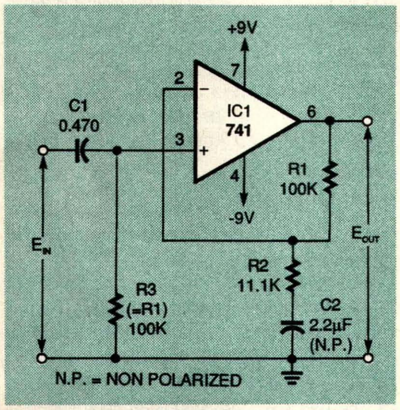


FIG. 8—NONINVERTING AC AMPLIFIER with a gain of 10.

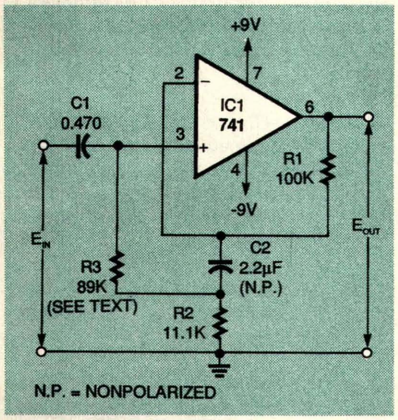


FIG. 9—NONINVERTING AC AMPLIFIER with a gain of 10 and 50-megohm input impedance.

features of special importance in certain applications, such as low noise, high slew rate, wide bandwidth, or various combinations of these.

Op-amp manufacturers specialize in either the high-volume, low-priced commodity or general purpose op-amps ("jelly beans") or more specialized, premium-priced (and often proprietary) devices for instrumentation, signal processing, and communications.

The Harris CA3140 is an example of a high-volume BiMOS op-amp that offers very high input impedance (1.0 × 10^{12} ohms) that can operate from either single or dual power supplies. The CA3140 combines the advantages of high-voltage PMOS transistors with high-voltage bipolar transistors on a single chip.

The CA3140 has a bipolar output stage, is internally compensated, and has the versatility of 741 op-amps. Column 2 of Table 1 lists some of its typical electrical characteristics.

National Semiconductor's LF411 is a low-cost, high-speed JFET input op-amp that is also made in volume. It offers low input offset voltage and low voltage drift. A large gain-bandwidth product and fast slew rate are maintained with low supply current. High-voltage input JFETs give the LF411 its low input bias and offset current. It is both pin-compatible and interchangeable with the 741. Column 3 of Table 1 lists some of its typical characteristics.

Linear amplifiers

There are many ways to configure op-amps as linear amplifier circuits. Although the 741 series op-amps is specified in the schematics discussed in the remainder of this article, all of the op-amps discussed here will work in these circuits.

Figure 7 shows an op-amp organized as an inverting AC amplifier with an overall voltage gain of 10. Noninverting input pin 3 is grounded through resistor R3. It has the same value as R2 to preserve the op-amp's DC balance. Input impedence Z_{IN} equals the value of resistor R1.

Figure 8 also shows the 741 configured as a noninverting AC amplifier with an overall voltage gain of 10. However, in this circuit modification, resistors R1 and R2 are isolated from ground by nonpolarized capacitor C2.

At normal operating frequencies, C2 has a low AC impedance, so voltage gain is still set by the ratios of R1 and R2. However, inverting input pin 2 receives all of the DC negative feedback through R1, giving the circuit excellent DC stability.

Again, for optimum biasing, resistor R3 should have the same value as R1. The op-amp's input impedance Z_{IN} at noninverting pin 3 is several hundred megohms, but it is shunted by resistor R3, which reduces the circuit's overall input impedance to approximately a 100-kilohms value.

Figure 9 shows how the circuit in Fig. 8 has been modified to give the op-amp a 50-megohm input impedance (Z_{IN}). The location of capacitor C2 has been changed, and the lower end of resistor R3 is connected to the junction of R2 and C2 rather than directly to ground.

The AC feedback signal that appears on the R2-C2 junction is nearly identical to the input signal at pin 3. As a result, nearly identical signal voltages appear on both ends of resistor

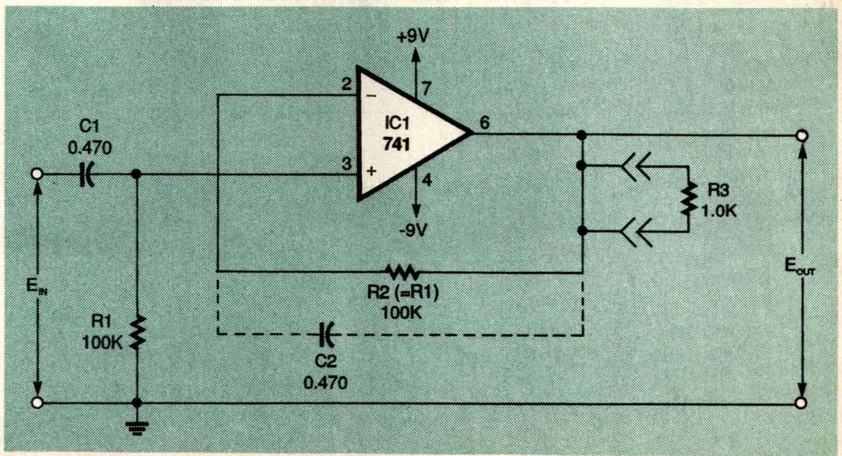


FIG.10—AC VOLTAGE FOLLOWER with 100-kilohm input impedance.

R3. Thus it passes negligible signal current.

Theoretically, the apparent impedance of R3 is raised to thousands of megohms by this "bootstrap"-feedback action, but in practical circuits the input impedance is limited to about 50 megohms by external leakage paths in the op-amp's mounting socket and/or the circuit board.

For optimum biasing of the circuit in Fig. 9, the sum of the values of resistors R2 and R3 should equal R1. However, in practical circuits the value of R3 can differ from this ideal by as much as 30%. Thus, a 100-kilohm resistor will work for R3.

Voltage followers

An op-amp can function as a voltage follower if the inverting and noninverting connections are combined for unity voltage gain. Ideally the differential amplifier's output responds only to the difference in voltage between the two inputs and does not respond to a voltage common to the two inputs (common-mode voltage).

Figure 10 illustrates some of the design options for a voltage follower with all of its negative feedback applied from output to inverting input pin 2 through resistor R2.

Ideally, resistor R1 (which determines the circuit's input impedance) and R2 should have equal values. Again, in practical circuits, the value of R2 can be any value up to 100 kilohms without significantly affecting circuit accuracy.

If the circuit's op-amp has a low-frequency cutoff value like that of the 741, R2 can usually have a value of zero. However, op-amps with high cutoff frequency values tend to be unstable when operated in the unity-gain mode.

Stability can be assured by installing an R2 of 100 kilohms, or by adding 1-kilohm plug-in resistor R3 in series. The 0.470µF capacitor C2 across R2 reduces the op-amp's AC impedance.

A very high input impedance can be obtained from an AC voltage follower by configuring the circuit as shown in Fig. 11. Resistor R1 is "bootstrapped" from the op-amp output through capacitor C2. Thus, the impedance of R1 is increased to the multimegohm range.

A 741 op-amp circuit will typically have an input impedance

(Continued on page 66)

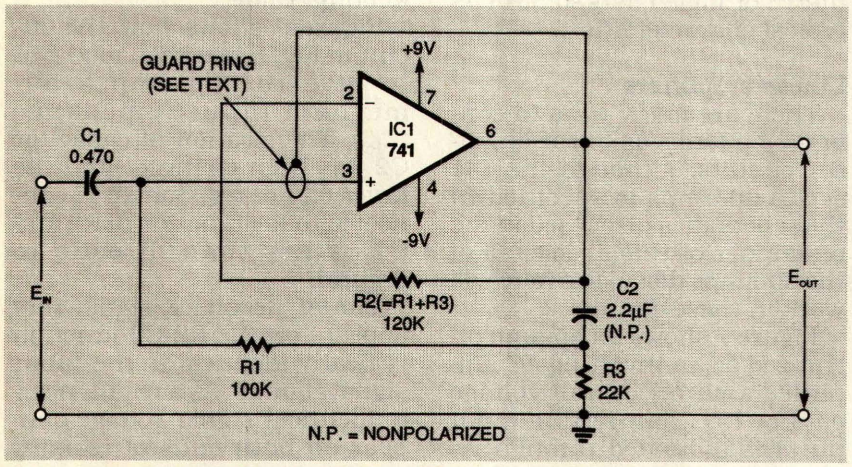


FIG. 11—AC VOLTAGE FOLLOWER with a 50-megohm input impedance.

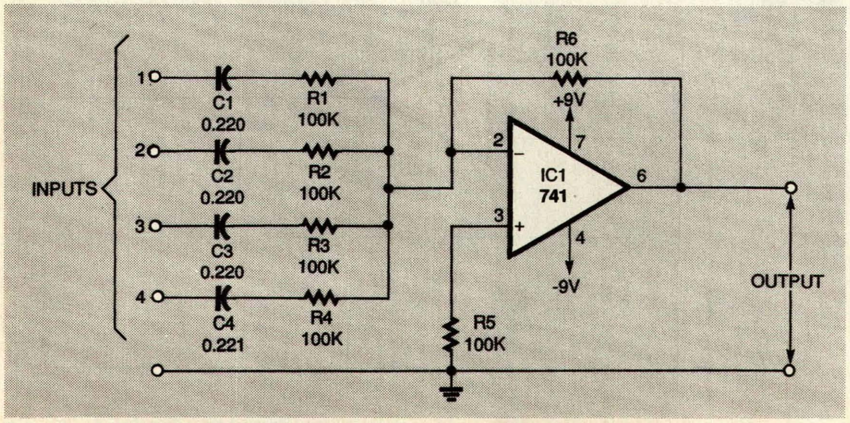


FIG. 12—SUMMING AMPLIFIER as a four-input audio mixer.

GLOSSARY OF TERMS

Input-offset voltage (V_{IO}). The differential input voltage required to produce zero output voltage.

Input offset current (I_{IO}). The difference between the two input currents.

Input bias current (I_B). The current flowing into (or out of) either input terminal while the output voltage is near zero volts.

Input resistance (R_{IN}). The ratio of a small change in the differential input voltage to a resulting change in the input current, with the output remaining in its linear region.

Large-signal voltage gain (A_{VO}). The ratio of the change in output voltage to the change in differential input voltage causing it. Also known as *open-loop voltage gain.*

Output voltage swing (V_O). The maximum output voltage available under specified loading conditions.

Common-mode rejection ratio (CMRR). The ratio of the change in the input common-mode voltage to the resulting change in input offset voltage created by it, usually expressed in decibels.

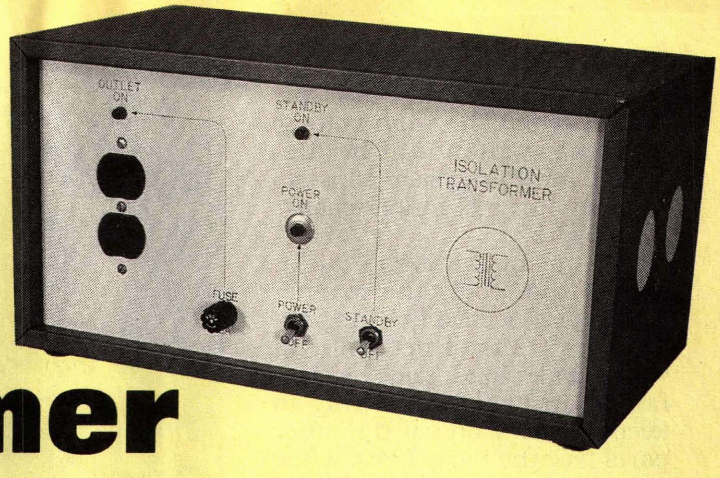
Supply current (I_S). The quiescent supply current required by the amplifier, measured when the output is zero volts so that no current is delivered to the load.

Slew rate (SR). The ratio of the output-voltage swing, measured from the 10 to 90% point of the leading or trailing edge, to the time required for the output to traverse this level, measured under large-signal conditions.

Unity gain bandwidth (BW). The frequency at which the open- loop gain is zero dB.

Gain-bandwidth product (GBW). The product of the available open-loop gain at a specified frequency times that frequency.

Build An Isolation Transformer



Build an isolation transformer to protect yourself—and your equipment—while you service electronics.

DOYLE WHISENANT

EVERYONE WHO REGULARLY SERVICES television sets really should have an isolation transformer. One side of the chassis of most line-powered TV receivers and tube-type radios is connected directly to the AC line. Therefore, servicing this electronic equipment can be very dangerous because the chassis can be "hot." An isolation transformer isolates the chassis of the equipment being serviced from the AC line. This article explains how to build an isolation transformer for a fraction of the price of a commercial product. It will even supply more current than most commercial units.

The heart of this project is the transformer. The author obtained the two transformers required from two discarded microwave ovens. Buying a new transformer for this project will not save you much money over buying a commercial isolation transformer because the transformer required can cost more than $150. For example, B&K Precision sells an isolation transformer for $189.00. Although electronics distributor Mouser Electronics sells one for $63.50, it will supply only 2.17 amperes, or about 250 watts. Even this modest price is almost three times what our complete project will cost!

Operation

Figure 1 is the schematic for the isolation transformer. Fuse-protected AC line power is first applied to power switch S1. When S1 is closed, neon power indicator NE1 lights up, and power is applied to a cooling fan and to standby switch S2. This arrangement allows transformer power to be turned off, while permitting the fan to continue cooling the transformer.

Neon standby indicator NE2 is wired across switch S2 so that it lights when S2 is open. When S2 is closed, power is applied to the primary side of 1:1 isolation transformer T1. The secondary side of T1 supplies isolated AC power to receptacle SO1. Neon indicator NE3 lights when power is applied to the receptacle SO1.

The isolation transformer will supply 1000 watts for short periods of time, and 500 watts or less continuously. However, it will run too hot if 500 watts is exceeded for more than about half an hour.

The transformer for this project was made from the windings of two microwave-oven transformers. Microwave ovens have heavy-duty transformers (see Fig. 2) that consist of three windings: a 120-volt AC input coil, a 2000- to 3000-volt AC output coil, and a 3- to 5-volt AC coil that serves as the filament winding for the oven's magnetron. The magnetron is the vacuum tube that produces the microwave energy for the oven.

The filament winding is easily identified; it consists of three to five single turns of 12- or 13-gauge enamel-covered wire. This winding is usually wound directly over the 120-volt AC winding which is wound from

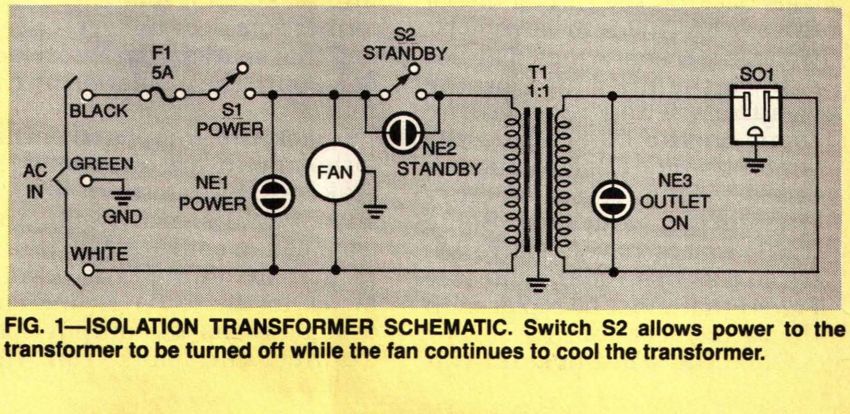


FIG. 1—ISOLATION TRANSFORMER SCHEMATIC. Switch S2 allows power to the transformer to be turned off while the fan continues to cool the transformer.

approximately the same size wire as the filament, but it has more turns. The high-voltage winding, which will be discarded for this project, consists of many turns of much smaller gauge wire.

The microwave oven's fan or blower that cools the magnetron is also needed for this project. The transformer will run warm under load, and the oven fan is an economical way to keep it cool. None of the other parts (see the Parts List), while commonly available, will be found in a microwave oven.

Modifying the transformer

Locate two surplus or discarded microwave ovens that are identical, or as similar as possible. As stated earlier, the transformers from two ovens are needed to build the isolation transformer. These transformers usually remain in good working condition. As an alternative, two surplus transformers might be easier for you to obtain than two scrap microwave ovens.

The pencil in Fig. 2 points to one of the welds that must be removed from the microwave-oven transformer. With a handheld grinder, very carefully grind away the welds on both sides of the transformer and separate the top core from the base. Figure 3 shows a transformer that has been disassembled. Remove the windings from the core, being careful not to disturb the insulation on the windings. Discard the high-voltage windings.

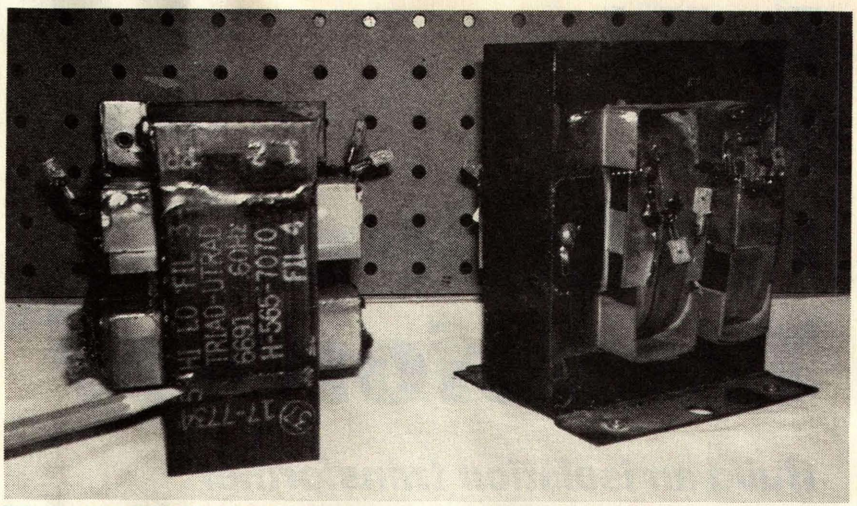


FIG. 2—THE TRANSFORMER for this project was made from two discarded microwave-oven transformers.

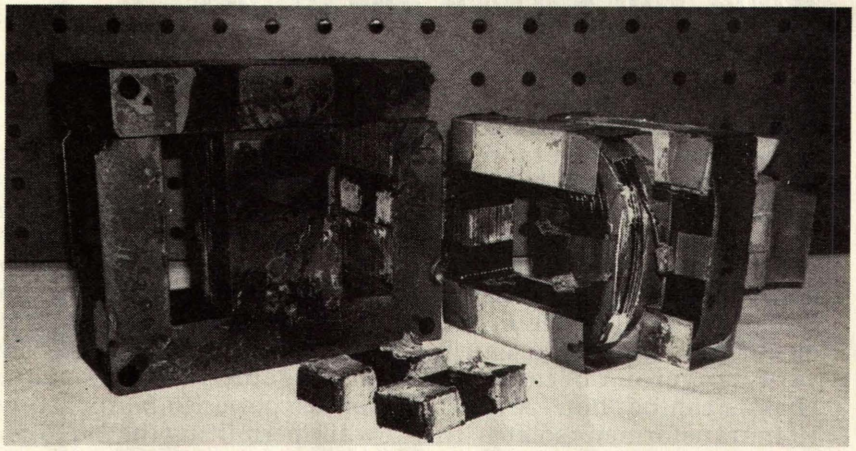


FIG. 3—DISASSEMBLED TRANSFORMER. Remove the windings from the transformer core, being careful not to disturb the insulation on the windings. Discard the high-voltage windings.

The 120-volt AC input coils from the two transformers will be used to make the isolation transformer. Place both 120-volt coils back on the core of one of the transformers to form a 1:1 isolation transformer. Do not disturb the insulation on the windings when reinstalling them on the core. Place the windings very close to one another to ensure satisfactory transformer coupling. Some transformers have spacers between the coils and the core (see Fig. 4) that must be replaced in the correct locations.

Once the windings are correctly positioned back on the core, reinstall the base of the transformer. To do this, weld the base back onto the transformer. If you have access to an electric welder and know how to use it, do this yourself. Otherwise, take the transformer to a welding shop and let a skilled welder do the job for you. Regardless of who does the welding, make sure that the transformer core does not get too hot and that sparks from the welder don't burn the insulation on the coils.

Check the completed transformer with an ohmmeter to make sure that there are no short circuits to the core and from coil to coil. Test the transformer by connecting a voltmeter to the leads of one coil designated as the output coil. Connect the leads from the other coil to an AC line cord through a 5-ampere fuse. Insulate all exposed connections.

Power up the transformer just long enough to get a reading on the voltmeter. Record the output reading, disconnect the AC power, and reverse the input and output coil connections. Repeat the procedure and check the output voltage again. Determine which output coil voltage measures closest to 120-volts AC; it will be the output side. The prototype transformer had a lower voltage reading in one direction than in the other.

Construction

This project requires a sturdy metal case that measures approximately 14- × 7- × 9-inches to hold both the fan and the transformer, and still have room for all connections.

This project consists of only a few parts, so point-to-point wiring can be used throughout. Figure 5 shows the inside of the prototype unit. Test fit the fan and the transformer before drilling any holes in the case. The fan should be mounted so that its air stream is directed at the transformer. Once the correct positions are determined for the fan and transformer, mark the locations and drill the mounting holes, but don't mount anything yet.

If you purchase the case specified in the Parts List, you will find that many of the necessary holes are already punched out. Otherwise, prepare the enclosure by drilling a hole and mounting the line cord to the back of the enclosure. Prepare the front of the enclosure by drilling holes to mount the neon indicators, NE1, NE2, and NE3. Then drill holes for switches S1 and S2. The prototype unit has two large holes punched in each end to allow the fan to draw in cool air and exhaust hot air. Place a screen over those holes to prevent debris from being drawn inside the unit. Prepare an opening for the duplex receptacle on the front panel with a nibbling tool.

PARTS LIST

- T1—Modified microwave oven transformer (see text)
- F1—5-ampere fuse and panel-mount fuse holder
- S1, S2—SPST 15-ampere toggle switch
- NE1–NE3—120-volt AC neon indicator lamp
- SO1—Standard duplex AC receptacle
- Metal case (Mendleson Electronics, 1-800-344-4465, Part No. 160-1782F or other suitable enclosure), grounded AC line cord, cooling fan from old microwave oven (see text), 14- to 16-gauge wire, terminal blocks, solderless connectors, wire ties, hardware

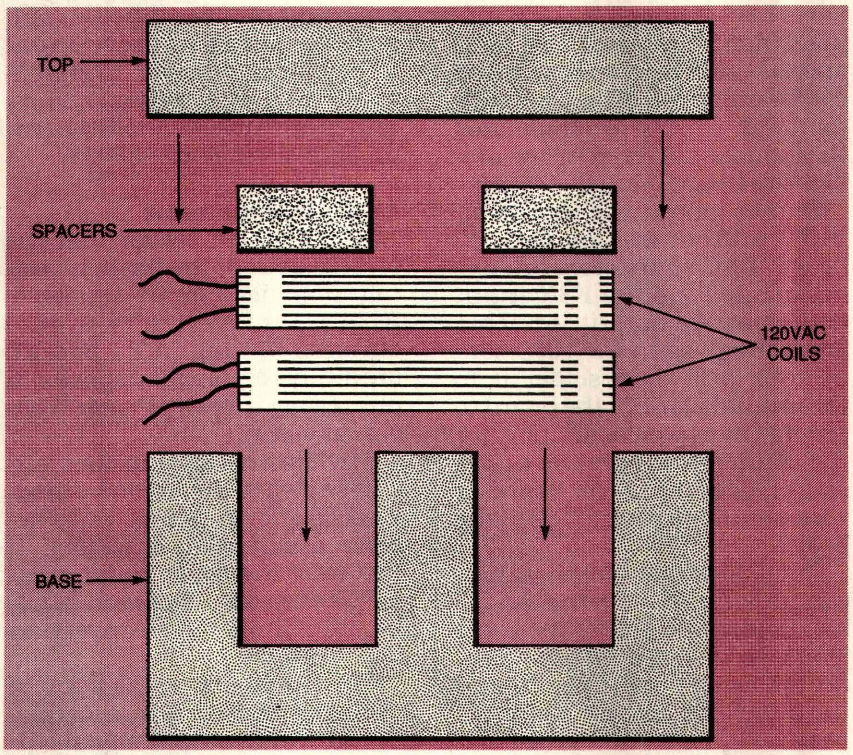


FIG. 4—**SOME TRANSFORMERS** have spacers between their coils and the core.

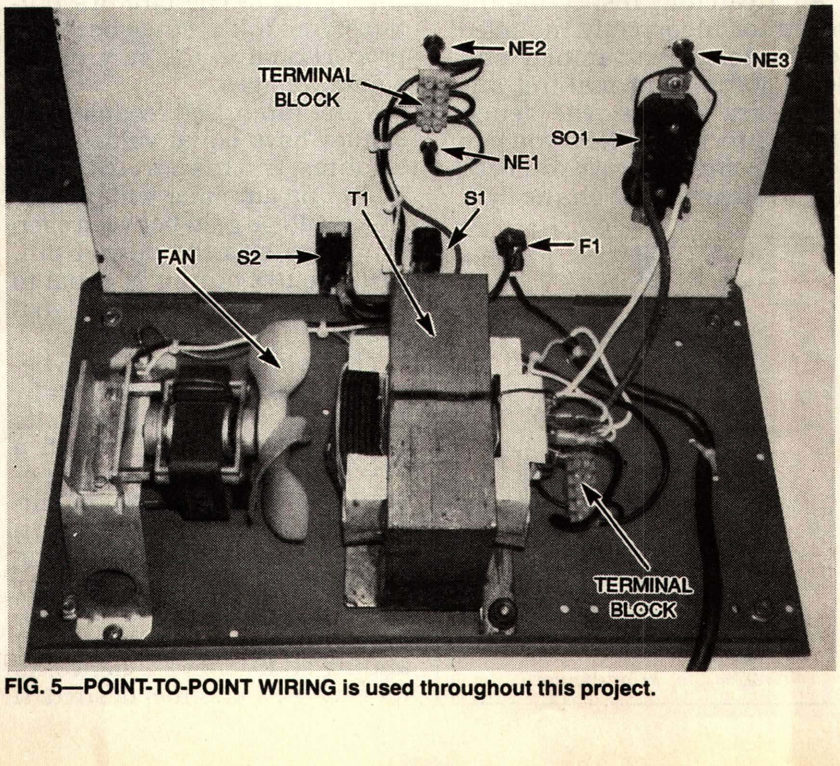


FIG. 5—**POINT-TO-POINT WIRING** is used throughout this project.

Once all the metal working on the enclosure is complete, it can be painted. Next label the enclosure; the labels can be protected with a coat of clear spray enamel.

When the enclosure is completely dry, the transformer and fan can be mounted. Start with the transformer, mounting it to the base of the enclosure with rubber washers to reduce vibration. Mount the fan in the direction so that the cooling air flow will be blowing over the transformer. Next install the fuse holder, the line cord, the three neon indicators, switches S1 and S2, and the duplex receptacle SO1.

The isolation transformer can produce several amperes of current, so use 14- to 16-gauge wire for all connections to and from the transformer. However, smaller gauge wire can be used for connecting the fan and neon indicators.

Refer to the schematic diagram (Fig. 1) and begin the wiring by connecting the hot side of the line cord (black wire) to one side of the fuse holder. Next solder a wire from the other side of the fuse holder to one terminal of the main power switch, S1.

Connect the other terminal of S1 to the other side of the fan and to one terminal of S2. Connect power indicator NE1 across the fan terminals so it will indicate when power is applied to the fan and to S2.

Standby switch S2 allows power to the transformer to be shut off while still allowing the fan to work. Wire indicator NE2 across S2 so that it illuminates when S2 is open, or when the unit is in the standby mode. Next, connect S2 to the other side of the transformer. Connect the neutral (white) wire from the line cord to one side of the fan and also connect it to one terminal on the input side of the transformer.

Connect both output leads of the transformer to the AC receptacle SO1. Next connect the output-power indicator NE3 across the receptacle. As a last important step, run a ground connection from the line cord (the green wire) to the base of the transformer and to the fan. If the transformer has not been grounded to the chassis, be sure to do so now with a separate wire.

Testing

Before closing up the case, plug an appliance such as a coffee maker, a lamp, or another appliance that draws about 500 watts into the isolation transformer outlet and turn on the power. Run the transformer with the load turned on for approximately 30 minutes while checking it every five minutes or so for excess heat.

The prototype was tested with an 800-watt coffee maker, and the transformer ran warm—but not hot—to the touch. Do not use the isolation transformer to power anything with that high a power rating for extended periods of time. Most modern TVs, even those with large screens, consume 350 watts or less. Ω

SINEWAVE GENERATOR

continued from page 52

Construction

A circuit board with a ground plane is required for building this project because of the high frequencies involved. You can make your own board or buy one from the source given in the Parts List. Figure 3 is the parts-placement diagram. The NCO and DAC ICs are expensive and can be damaged if they must be removed, so it is recommended that you install them in low-profile, machined-contact sockets.

Do not mount the input/output connectors on the PC board. BNC connectors are recommended for the FSK input and sinewave output. Attach a grounding lug to the BNC connectors, and then solder it to the ground plane of the board to provide mechanical support for the connectors. Wire the power source directly to the board or wire a suitable power jack to the board.

Cut a four-foot length of five-conductor cable for the PC cable. Solder one end of the cable leads to a male DB-25 connector, as shown in Fig. 3, and the other end directly to the PC board. Figure 4 shows the complete board.

After carefully inspecting the board for incorrectly installed components and poorly soldered joints and making any necessary repairs, the generator is functional. Now you can generate any sinewave you need up to 10 megahertz on the fly. Ω

Go ahead. . .it's an old schematic.

OP-AMPS

continued from page 62

of about 50 megohms. As stated earlier, this limit is set by the leakage impedance caused by the mounting socket and/or circuit board. A conductive trace "guard ring" on the circuit board surrounding noninverting input pin 3 and tied to output pin 6 will improve input impedance. However, if significantly higher impedance is required, substitute an FET-input op-amp such as the LF411.

Audio mixer circuit

It was stated earlier that the voltage gain of the basic inverting amplifier circuit equals −R1/R2. Consequently, signal currents flowing in R1 and R2 are always equal but opposite in phase, regardless of their individual values.

The inverting amplifier circuit shown in Fig. 5 can be modified as shown in Fig. 12 to become a *summing amplifier*. It has four identical resistor-capacitor input networks in parallel, all connected to inverting input pin 2.

The signal current flowing in feedback resistor R6 will equal the sum of the input signal currents flowing in resistors R1 through R4. The circuit's output signal voltage then becomes proportional to the sum of the signal voltages.

If the input and feedback resistors have equal values (100 kilohms in this circuit), the summing amplifier will provide unity voltage gain between each input pin and the output pin. The circuit's output is equal to the sum of the four input signal voltages.

This simple circuit can become a practical audio mixer by feeding each input signal to its input network channel with a 10-kilohm, volume-control potentiometer. If desired, the circuit can provide voltage gain greater than unity by increasing the value of feedback resistor R6. The number of input channels can also be increased by adding additional RC networks for each new channel desired. Ω

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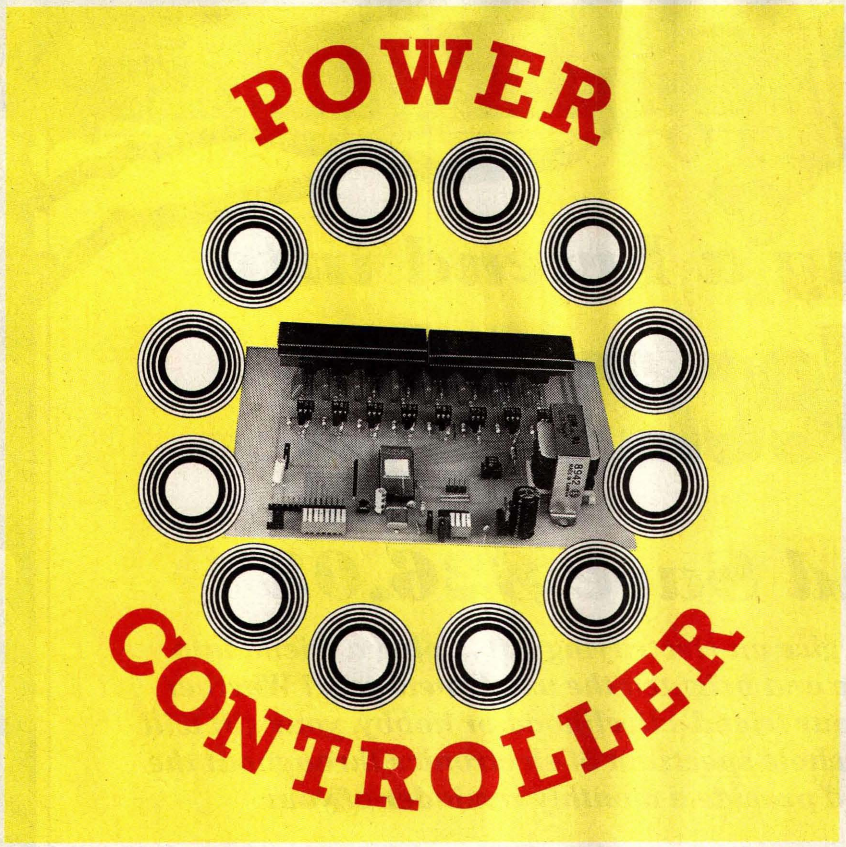


POWER CONTROLLER

Control eight channels of 120-volt AC with a 68705.

RICHARD L. ROANE

HAVE YOU EVER WANTED TO VARY the power delivered to a 120-volt AC load under software control? In this project a 68705 microcontroller will do just that. Specifically, it can control eight discrete power Triacs, each of which delivers power in 32 smoothly graduated steps ranging from 0 to 97% of full power. The value delivered to one channel is independent of the value delivered to any other channel. Loads can include light displays, universal motors, heaters, and other appliances.

In this circuit, the power level is set by software, not a potentiometer. The software includes a basic set of routines for processing interrupts and setting the power level. The software also includes five test and demonstration routines for putting the circuit through its paces. Moreover, there's plenty of room to add your own routines to the 68705's built-in EPROM. An easy-to-build single-sided circuit board makes assembly easy.

The basic circuit is simple, yet versatile enough to accept inputs from on-board DIP switches; alternatively, the inputs can be driven from a microcomputer bus or parallel port, or a stand-alone device with TTL-compatible outputs. There are 12 input bits to set modes and specify values.

Circuit design

The circuit, shown in Fig. 1, consists of a power supply, AC line synchronizer, Triac output control, input circuitry, and support devices.

The power supply is a conventional 5-volt circuit built around a 7805 regulator (IC3) and several other components (transformer T1, bridge BR1, and C1–C4). The AC line synchronizer consists of an optocoupler (IC2), a current-limiting resistor (R1), and a bias resistor (R2). The power controller generates variable power levels with phase-control techniques. When using a Triac to control a load, the power delivered can be varied by triggering the Triac after the start of an AC half-cycle.

For example, by triggering the Triac shortly after the start of a half-cycle, the load will receive almost full power. Triggering in the middle of a half-cycle will supply the load with half power and triggering close to the end of a half-cycle will result in the load receiving little power.

In this project the controller is synchronized to AC power-line zero crossings, which occur at a rate of 120 times per second. The microprocessor's internal timer then divides the interval between crossings into 32 steps, thus delivering gradually increasing amounts of power to the load.

The output of the optocoupler is a negative-going pulse that drives the microcontroller's interrupt input directly at a rate of 120 hertz. Each time IC1 receives an interrupt, it recalculates the time to generate Triac trigger pulses on Port B of IC1.

Each bit of Port B is connected to a Triac control circuit; since they're all identical, only Port 7 will be described in detail. Port B7 of IC1 drives transistor Q1 via resistor R4. (Q1 is required because the 68705 can't sink enough current to trigger Triac-driver IC4 directly.)

When it's time to turn on Triac TR1, the microcontroller delivers a 10-microsecond negative-going pulse to port PB7. That pulse briefly enables the transistor, which causes current flow through the LED inside IC4. Although a Motorola MCP3011 Triac driver was used in this design, any similar device could be used, as long as it doesn't have an internal zero-crossing detector. That type of driver allows only two modes of operation: full on and full off.

The Triac driver's LED then triggers the photon-coupled Triac within the IC, which in turn triggers TR1 and delivers power to the external load. Resistor R5 provides current limiting for IC4, and R6 and C7 form a snubber network to filter line transients that could cause the Triac to trigger falsely.

The hot side of the power line connects to the MT1 terminal of all the power Triacs (TR1–TR8). The specified Triacs are rated for 4 amperes at 200 volts. They are isolated-tab versions, and were selected because heatsinking is mandatory. With the specified Triacs, the maximum load is 100 watts per output. Larger loads can be handled by substituting Triacs with higher current ratings. Be sure to use proper heatsink and isolation techniques.

Input circuit

The input circuit consists of Ports A and C of the microcontroller, along with two banks each of DIP switches (S1 and S2), SIP resistors (RN1 and RN2), four sets of 0.1 inch header jumpers (P1–P4) for mode selection, a 14-pin header (P5) connected to Port A, and a four-pin header (P6) for input selection.

The P1–P4 jumpers allow both the common resistor legs and the common switch poles to be tied to either ground or +5-volts DC, or to be disconnected from the circuit entirely. If programmed as inputs, the ports should not be left floating because this might cause erratic operation. Connector P6 allows an external device (e.g., a computer) to drive the controller's inputs.

The 68705P3 requires a few support components. Crystal XTAL1 runs at a frequency of 3.58 megahertz, which should not be altered. Capacitor C5 loads the oscillator to keep it at the correct frequency, and capacitor C6 keeps the reset pin low for an instant, thereby giving the 68705 time to stabilize after power up. Momentary switch S3 provides for resetting the circuit. Although unused in the prototype, an external connection is provided to the microcontroller's RESET input, which could allow an external device to reset the circuit when desired.

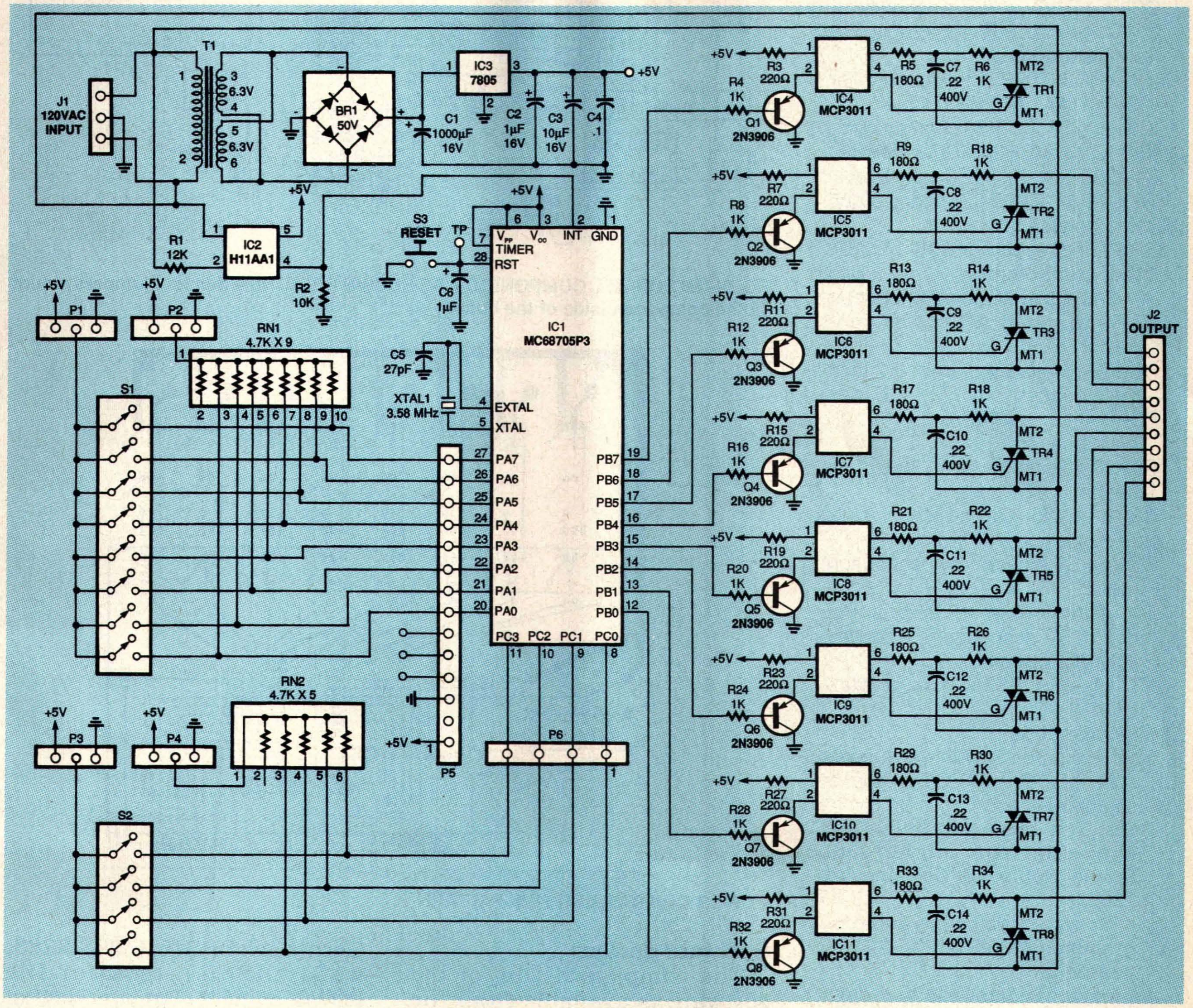

J1
120VAC INPUT
T1
6.3V
6.3V
BR1
50V
IC3
7805
C1
1000µF
16V
C2
1µF
16V
C3
10µF
16V
C4
.1
+5V
R1
12K
IC2
H11AA1
R2
10K
S3
RESET
TP
C6
1µF
C5
27pF
XTAL1
3.58 MHz
IC1
MC68705P3
VPP TIMER
VCC
INT
GND
RST
EXTAL
XTAL
PA7
PA6
PA5
PA4
PA3
PA2
PA1
PA0
PB7
PB6
PB5
PB4
PB3
PB2
PB1
PB0
PC3
PC2
PC1
PC0
P1
P2
P3
P4
P5
P6
RN1
4.7K X 9
RN2
4.7K X 5
S1
S2
R3
220Ω
R4
1K
Q1
2N3906
IC4
MCP3011
R5
180Ω
C7
.22
400V
R6
1K
MT2
MT1
G
TR1
R7
220Ω
R8
1K
Q2
2N3906
IC5
MCP3011
R9
180Ω
C8
.22
400V
R18
1K
TR2
R11
220Ω
R12
1K
Q3
2N3906
IC6
MCP3011
R13
180Ω
C9
.22
400V
R14
1K
TR3
R15
220Ω
R16
1K
Q4
2N3906
IC7
MCP3011
R17
180Ω
C10
.22
400V
R18
1K
TR4
R19
220Ω
R20
1K
Q5
2N3906
IC8
MCP3011
R21
180Ω
C11
.22
400V
R22
1K
TR5
R23
220Ω
R24
1K
Q6
2N3906
IC9
MCP3011
R25
180Ω
C12
.22
400V
R26
1K
TR6
R27
220Ω
R28
1K
Q7
2N3906
IC10
MCP3011
R29
180Ω
C13
.22
400V
R30
1K
TR7
R31
220Ω
R32
1K
Q8
2N3906
IC11
MCP3011
R33
180Ω
C14
.22
400V
R34
1K
TR8
J2
OUTPUT

FIG. 1—COMPLETE SCHEMATIC OF THE 68705-based power controller. The controller reads switch values from Ports A and C, and delivers software-controlled 120-volt AC power to Port B.

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.

R1—12,000 ohms, 1 watt
R2—10,000 ohms
R3, R7, R11, R15, R19, R23, R27, R31—220 ohms
R4, R6, R8, R10, R12, R14, R16, R18, R20, R22, R24, R26, R28, R30, R32, R34—1000 ohms
R5, R9, R13, R17, R21, R25, R29, R33—180 ohms
RN1—4700 ohms × 9 resistor network, common terminal
RN2—4700 ohms × 5 resistor network, common terminal

Capacitors

C1—1000 µF, 16V, radial electrolytic
C2—1 µF, 16V, tantalum
C3—10 µF, 16V, radial electrolytic
C4, C15—0.1 µF, monolithic
C5—27 pF, ceramic
C6—1 µF, 16V, radial electrolytic
C7–C14—0.22 µF, 400V, poly film

Semiconductors

IC1—MC68705P3 microcontroller
IC2—H11AA1 AC optocoupler
IC3—MC7805CT 5-volt regulator
IC4–IC11—MCP3011 Triac driver
Q1–Q8—2N3906 NPN transistor
TR1–TR8—Q2004L3 Triac, 200V, 4A, isolated tab
BR1—Bridge rectifier, 50V, 1A, DIP

Other components

J1—3-terminal AC power connector
J2—9-terminal AC power connector
P1–P4—3-pin single-row 0.1 inch male header
P5—14-pin single-row 0.1 inch male header
P6—4-pin single-row 0.1 inch male header
S1—8-position DIP switch
S2—4-position DIP switch
S3—SPST momentary pushbutton switch
T1—Transformer, 120V primary, dual 6.3V secondaries (Digi-key T101-ND or equiv.)
XTAL1—3.579545 MHz crystal, HC-18

Miscellaneous

Shorting jumpers for P1—P4, heatsink for TR1—TR8, PC board, solder, wire, etc.

Note: The following items are available from Richard L. Roane, Route 601, Cologne, VA 23037:

- **Source code listing and programmed MC68705P3—$24.95 postpaid**

VA residents must add appropriate sales tax.

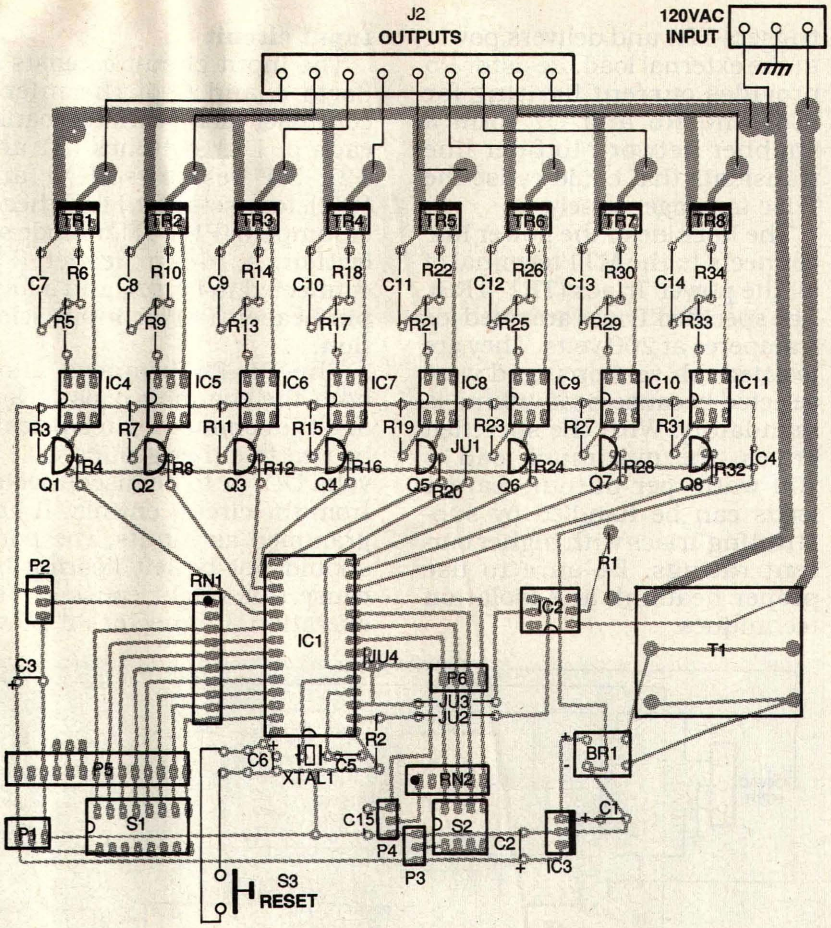
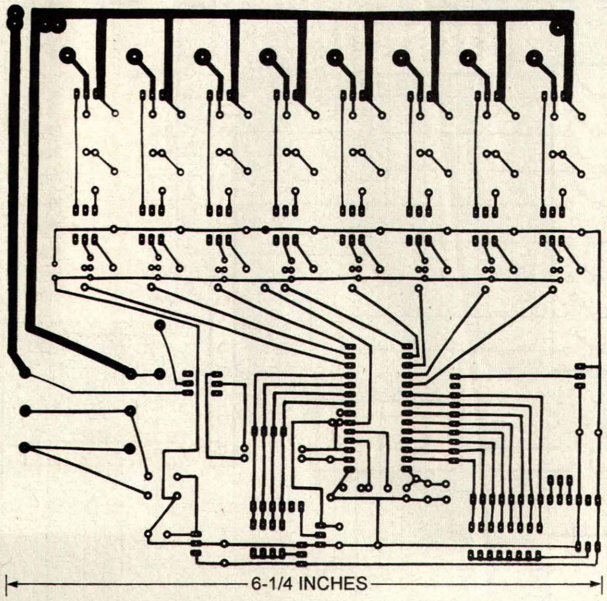

J2
OUTPUTS
120VAC
INPUT
TR1
TR2
TR3
TR4
TR5
TR6
TR7
TR8
C7
R6
C8
R10
C9
R14
C10
R18
C11
R22
C12
R26
C13
R30
C14
R34
R5
R9
R13
R17
R21
R25
R29
R33
IC4
IC5
IC6
IC7
IC8
IC9
IC10
IC11
R3
R7
R11
R15
R19
R23
R27
R31
JU1
R4
R8
R12
R16
R20
R24
R28
R32
C4
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
R1
P2
RN1
IC2
IC1
JU4
T1
C3
P6
JU3
JU2
R2
C6
C5
XTAL1
BR1
P5
RN2
C15
S2
C1
P1
S1
P4
C2
P3
IC3
S3
RESET

FIG. 2—MOUNT ALL COMPONENTS AS SHOWN HERE. Note that four jumpers mount on the component side of the board.



POWER CONTROLLER FOIL PATTERN.

Software design

The complete listing of the software is available from the author, as detailed in the Parts List. It is also available on the Gernsback BBS (516-293-2283, v.32, v.42bis); look for file POWCON.ASM. An overview of the major routines follows:

The interrupt routine sets up

TABLE 1—POWER LEVELS

Power Level	Voltage (VAC)	Percent On (%)
0	1.2	1.0
1	1.9	1.6
2	2.6	2.2
3	6.6	5.5
4	9.2	7.7
5	12.2	10.2
6	15.6	13.0
7	19.5	16.3
8	23.6	19.7
9	27.9	23.3
10	32.8	27.3
11	37.7	31.4
12	42.9	35.8
13	48.2	40.2
14	53.6	44.7
15	59.0	49.2
16	64.4	53.7
17	70.8	59.0
18	75.2	62.7
19	80.2	66.8
20	85.2	71.0
21	90.0	75.0
22	94.5	78.8
23	97.8	81.5
24	101.6	84.7
25	105.3	87.8
26	107.3	89.4
27	110.2	91.8
28	112.7	93.9
29	114.8	95.7
30	116.4	97.1
31	0.0	0.0

TABLE 2
APPLICATION AND JUMPER SELECTION

Value	Application	JU1	JU2	JU3	JU4
0	Manual	GND	+5	+5	GND
1	External	-	-	+5	GND
2	Sequencer	-	-	+	GND
3	Run and Flash	-	-	+	GND
4	Test	-	-	+5	GND
5-15	Not used				

TABLE 3
MANUAL MODE POWER LEVELS

Port C Data Decimal	Power Level Decimal
0	31
1	0
2	2
3	4
4	6
5	8
6	10
7	12
8	14
9	16
10	18
11	20
12	22
13	24
14	26
15	30

the microcontroller's internal timer to produce 31 timer interrupts per half-cycle. Together with the full-off value, those interrupts provide the 32 power levels. Table 1 lists power level, corresponding voltage, and percentage of full on. A power value of 0 represents the lowest on voltage, 30 represents the highest, and anything greater than 30 represents a voltage of 0.0.

Eight bytes of RAM (PWRC0–PWRC7) function as control bytes, each corresponding to a Port B output bit. Each byte stores one item of power level data (as shown in column 1 of Table 1). To see how a value in a control byte is translated into an output voltage, follow this example.

Suppose that an application calls for a power level of 16 at Output 3, and a level of 30 at Output 7. In that case simply store values of 16 and 30 in control bytes PWRC3 and PWRC7, respectively. The outputs will immediately and simultaneously reflect these levels. Note that although the desired voltages were specified in decimal form, you must store the corresponding hexadecimal value in the output-control byte.

A "hole" was left in the microcontroller's EPROM (addresses $80–$5FF) for application programs. The five demonstration routines discussed earlier occupy those addresses. You are free to create your own applications, but leave the addresses outside that range alone. Addresses below $80 are reserved for constant and variable storage; addresses above $5FF contain the reset and interrupt routines. All 68705 registers, except for the timer, are available for use by application routines.

ASSEMBLER VARIATIONS

In developing the software for this article, the intention was to provide a single source file that would assemble correctly under three assemblers: the TECI 6805 Assembler, Motorola's 6805 Assembler, and Motorola's Freeware Assembler. In the course of testing, a bug was discovered in the Freeware assembler. After encountering an instruction that uses direct addressing on page zero of memory, the assembler starts generating garbage. Both of the other assemblers force extended addressing, thus avoiding the problem. The only point in the code where this is a problem is in the jump table, where there is the instruction:

```
JMAN: JMP MAN
```

By changing that instruction as follows, the problem can be avoided:

```
JMAN: BRA MAN
```

Branching, rather than jumping, works because the target routine is within 128 bytes of the jump table.

Construction

Assembly is straightforward. Figure 2 shows the parts layout on the single-sided circuit board. Load the board by inserting lowest- to highest-profile

(Continued on page 76)

900 MHz breakthrough!

New technology launches wireless speaker revolution...

Recoton develops breakthrough technology which transmits stereo sound through walls, ceilings and floors up to 150 feet.

Wireless
Recoton

Breakthrough wireless speaker design blankets your home with music.

By Charles Anton

If you had to name just one new product "the most innovative of the year," what would you choose? Well, at the recent *International Consumer Electronics Show*, critics gave Recoton's new wireless stereo speaker system the *Design and Engineering Award* for being the "most innovative and outstanding new product."

Recoton was able to introduce this whole new generation of powerful wireless speakers due to the advent of 900 MHz technology. This newly approved breakthrough enables Recoton's wireless speakers to rival the sound of expensive wired speakers.

Recently approved technology. In June of 1989, the *Federal Communications Commission* allocated a band of radio frequencies stretching from 902 to 928 MHz for wireless, in-home product applications. Recoton, one of the world's leading wireless speaker manufacturers, took advantage of the FCC ruling by creating and introducing a new speaker system that utilizes the recently approved frequency band to transmit clearer, stronger stereo signals throughout your home.

Crisp sound throughout your home. Just imagine being able to listen to your stereo, TV, VCR or CD player in any room of your home without having to run miles of speaker wire. Plus, you'll never have to worry about range because the new 900 MHz technology allows stereo signals to travel over distances of 150 feet or more through walls, ceilings and floors without losing sound quality.

One transmitter, unlimited receivers. The powerful transmitter plugs into a headphone, audio-out or tape-out jack on your stereo or TV component, transmitting music wirelessly to your speakers or headphones. The speakers plug into an outlet. The one transmitter can broadcast to an unlimited number of stereo speakers and headphones. And since each speaker contains its own built in receiver/amplifier, there are no wires running from the stereo to the speakers.

Full dynamic range. The speaker, mounted in a bookshelf-sized acoustically constructed cabinet, provides a two-way bass reflex design for individual bass boost control. Full dynamic range is achieved by the use of a 2" tweeter and 4" woofer. Plus, automatic digital lock-in tuning guarantees optimum reception and eliminates drift. The new technology provides static-free, interference-free sound in virtually any environment. These speakers are also self-amplified; they can't be blown out no matter what your stereo's wattage.

Stereo or hi-fi, you decide. These speakers have the option of either stereo or hi-fi sound. You can use two speakers, one set on right channel and the other on left, for full stereo separation. Or, if you just want an extra speaker in another room, set it on mono and listen to both channels on one speaker. Mono combines both left and right channels for hi-fi sound. This option lets you put a pair of speakers in the den and get full stereo separation or put one speaker in the kitchen and get complete hi-fi sound.

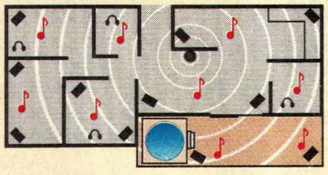
These wireless stereo headphones have a built-in receiver.

Factory direct savings. Our commitment to quality and factory direct pricing allows us to sell more wireless speakers than anyone! For this reason, you can get these speakers far below retail with our 30 day *"Dare to Compare"* money-back guarantee and full one year manufacturer's warranty. For a limited time, the Recoton transmitter is only $69. It will operate an unlimited number of wireless speakers priced at $89 and wireless headphones at $59 each. Your order will be processed in 72 hours and shipped UPS.

150 foot range through walls!

Recoton gives you the freedom to listen to music wherever you want. Your music is no longer limited to the room your stereo is in. With the wireless headphones you can listen to your TV, stereo or CD player while you move freely between rooms, exercise or do other activities. And unlike infrared headphones, you don't have to be in a line-of-sight with the transmitter, giving you a full 150 foot range.

The headphones and speakers have their own built-in receiver, so no wires are needed between you and your stereo. One transmitter operates an unlimited number of speakers and headphones.

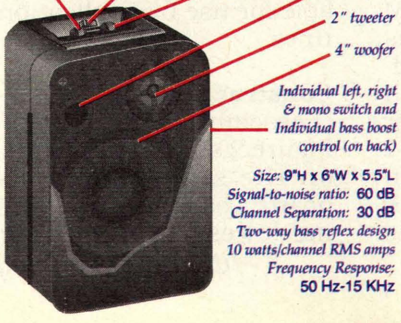


Recoton's transmitter sends music through walls to wireless speakers over a 75,000 square foot area.

AWARD WINNING WIRELESS SPEAKER

Built-in receiver and amplifier:

The wireless speaker and headphones both contain a built-in receiver and amplifier. Signals are picked up and transmitted as far as 150 feet away through walls without the use of wires.


Volume
Power
Tuning
Tuned ports
2" tweeter
4" woofer
Individual left, right & mono switch and Individual bass boost control (on back)

Size: 9"H x 6"W x 5.5"L
Signal-to-noise ratio: 60 dB
Channel Separation: 30 dB
Two-way bass reflex design
10 watts/channel RMS amps
Frequency Response; 50 Hz-15 KHz

Don't take our word for it. Try it yourself. We're so sure you'll love the new award-winning Recoton wireless speaker system that we offer you the **Dare to Compare Speaker Challenge.** Compare Recoton's rich sound quality to that of any $200 wired speaker. If you're not completely convinced that these wireless speakers offer the same outstanding sound quality as wired speakers, simply return them within 30 days for a full "No Questions Asked" refund.

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Recoton's Design and Engineering Award

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1994
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Electronics NOW® Volume 65

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  - Compression, The Sound of (Klein)(AUD) Dec 86
  - Multimeter, Benchtop, Wavetek BDM40 (ER) Jul 20
- Directional Hearing (Klein)(AUD) Nov 80
- Disk Dilemma (QA) Jan 10,(LET)Oct 10
- Disk Drive, Solid-State (Hatten)(C) Apr 49
- Distinctive Ring Decoder, Build This (Keefe)(C) Mar 43
- **Dowsing**
  - Resources (Lancaster)(HH) Aug 77,(LET)Oct 10
  - More on (Lancaster)(HH) Nov 71
- **DRAWING BOARD (Grossblatt)(D)** Jan 28,Feb 82, Apr 24,May 86,Jun 29, Jul 80,Sep 84,Oct 86,Nov 86
  - Adding Old-Fashioned Gauges to Modern Automobiles Jan 28
  - Alternate Tachometer Design Takes Shape, Our Oct 86
  - Closer Look at our Automotive Power Supply, A May 86
  - Completing the Tachometer's Spark-Counter Section Nov 86
  - Different Tachometer Design Approach, A Sep 84
  - Our Automotive Power Supply Comes to Life Feb 82
  - PLL Section of our Tachometer, The Jul 80
  - Two Possible Designs for our Tachometer's Counting Circuit Jun 29
  - Why Build a Tachometer? Apr 24
- Dynamics of Music and the Evolution of Audio Instrumentation (Klein)(AUD) Mar 16

E

- **EDITORIAL (D)** Mar 6
  - Keeping Up Your Technical Skills (Steckler) Mar 6
- Electric Vehicle Information (Lancaster)(HH) Mar 81
- Electronic Face, The (Sonntag)(C) Jul 41
- Elenco Electronics SM-220K Decision Maker (ER) Apr 16
- Elusive Readings (QA) Apr 10
- EMI and RFI Differences (QA) Oct 8
- Environmental Semiconductor Testing (Byers) Nov 55
- **EQUIPMENT REPORTS (D)** Jan 18,Feb 20, Mar 22,Apr 16,May 16, Jun 19,Jul 20,Aug 11, Sep 22,Oct 16,Nov 14,Dec 18
  - B + K Precision LCR Bridge Sep 22
  - Compuvideo Oscilloscope-to-Vectorscope Converter May 16
  - Cybermations SCK-2000 Stepper-Motor Controller Aug 11
  - Dallas Semiconductor DS1620 Demonstration Kit Mar 22
  - DIC SC-7000 Desoldering Tool Jan 18
  - Elenco Electronics SM-220K Decision Maker Apr 16
  - Hewlett-Packard HP 970 Series Multimeters Dec 18
  - ITT Pomona Logic Scope Probe Feb 20
  - Jameco Electronics JE725 Digital Clock Kit Nov 14
  - L-Com DXB65 Ethernet Cable Tester Jun 19
  - Tektronix Tekmeter Portable Oscilloscope Oct 16
  - Wavetek BDM40 Benchtop Digital Multimeter Jul 20
- Ethernet Cable Tester, L-Com DXB65 (ER) Jun 19
- Evolution of Audio Instrumentation and the Dynamics of Music (Klein)(AUD) Mar 16

F

- Falling Prices are not Necessarily a Good Thing (Holtzman)(CC) Jan 88
- Fan Shut-Off (QA) Feb 12
- Flashlight, Automatic Rechargeable (Spiwak)(C) Oct 65
- FM DX Reception (Lancaster)(HH) Jun 83
- Follow that Noise (QA) Jun 10
- Frequency Doubler (Yacono)(C) Nov 44
- Fun With Function Generators (Kral) Oct 42

G

- General Magic Has Something Up Its Sleeve (Holtzman)(CC) May 90

H

- Hacker Opportunities (Lancaster)(HH) Jul 71
- Hacker's Data Exchange (Lancaster)(HH) Feb 73
- **HARDWARE HACKER (Lancaster)(D)** Jan 80,Feb 73, Mar 81,Apr 85,May 75, Jun 83,Jul 71,Aug 77, Sep 75,Oct 75,Nov 71,Dec 77
  - The Fundamentals of SCSI Communications Apr 85
  - Basic Research Tools and Refilling Canon EX Toner Cartridges Aug 77
  - Powerful New PIC Software, and More Dec 77
  - Hacker's Data Exchange, and More Feb 73
  - Multimedia Resources, and More Jan 80
  - Second Law Violations and Hacker Opportunities Jul 71
  - Tough Audio Amplifiers, and More Jun 83
  - Jukebox Resources, and More Mar 81
  - RBDS Services, and More May 75
  - More on Dowsing Nov 71
  - Major SETI Developments, and More Oct 75
  - Cold Fusion Update, and More Sep 75
- Helical Resonators (Lancaster)(HH) Nov 71
- Hewlett-Packard HP 970 Series Multimeters (ER) Dec 18
- Home Control, Power Line Modem for (Keefe)(C) Mar 57
- Human-Powered Vehicles (Lancaster)(HH) May 75

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- Identifying Capacitors (QA) May 10
- **Impedance**
  - Matching (QA) Apr 10,(LET)Jul 16
  - Mystery (QA) Sep 8
- Invention Marketing Scams (Lancaster)(HH) Jun 83
- ITT Pomona Logic Scope Probe (ER) Feb 20

J

- Jameco Electronics JE725 Digital Clock Kit (ER) Nov 14
- Joys of Audio Clipping, The (Klein)(AUD) Sep 82
- Jukebox Resources (Lancaster)(HH) Mar 81

K

- Keeping Up Your Technical Skills (Steckler)(ED) Mar 6
- **KITS**
  - Jameco Electronics JE725 Digital Clock Kit (ER) Nov 14
  - Elenco Electronics SM-220K Decision Maker (ER) Apr 16

L

- L-Com DXB65 Ethernet Cable Tester (ER) Jun 19
- Laser Service Manual (Lancaster)(HH) Nov 71
- "LED-Head," The (Sonntag)(C) Jul 41
- **LETTERS (D)** Jan 16,Feb 16,Mar 18, Apr 12,May 12,Jun 14, Jul 16, Aug 12,Sep 16,Oct 10,Nov 8,Dec 12
- LCR Bridge, B + K Precision (ER) Sep 22
- Light-Controlled Sound-Effect Generator, Build This (Canivan)(C) Sep 65
- Light-to-Frequency Converters (Lancaster)(HH) Oct 75
- Line Grabber, Telephone (Iannini)(C) Sep 43
- Linear to Log Converter (QA) Jun 10,(LET)Sep 16
- Logic Scope Probe, ITT Pomona (ER) Feb 20
- Long-Range Body-Heat Detector (Iannini)(C) Feb 38
- Lost Art of Regeneration, The (Kitchin)(C) Mar 66,(LET)Jun 14
- Lotus/Smart Suite (Holtzman)(CC) Mar 91
- Low Cost Colorimeter (Schnable, Alessandro & Orr)(C) May 45
- Low-Distortion Sinewaves (Lancaster)(HH) Jan 80

M

- Magic Cap, General Magic's (Holtzman)(CC) May 90
- MCA-to-ISA Adapter (QA) Jul 10
- Memory Confusion (QA) Apr 10
- Micro-Lights (Retzinger)(C) Dec 39
- MicroConductor, The (Tarchinski)(C) Sep 49
- **Microcontroller Programmer**
  - 68705 (Beard)(C) Jan 43
  - PIC (Eady) Jan 35,Feb 48
- **Microsoft**
  - Office (Holtzman)(CC) Mar 91
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- Modem Communications Standards (Bigelow) Sep 35
- Monitor, Radon (Neher)(C) Jan 56,Feb 66
- Morse Code Tutor (Tarchinski) Sep 69
- Motor Speed Controller (QA) May 10
- Multimedia Resources (Lancaster)(HH) Jan 80
- Multimeters, Hewlett-Packard HP 970 Series (ER) Dec 18

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- National Electronics Technicians Day Apr 77
- National Information Infrastructure, The (Holtzman)(CC) Feb 88
- New Age of Satellite TV, The (Fenton) Apr 33
- New Life for Old Scopes (Covington) Sep 57
- **NEW LITERATURE (D)** Jan 24,Feb 26,Mar 32, Apr 26,May 26,Jun 24,Jul 26,Aug 22, Sep 30,Oct 26,Nov 22,Dec 24
- **NEW PRODUCTS (D)** Jan 20,Feb 21,Mar 24, Apr 20,May 20,Jun 20,Jul 22,Aug 18, Sep 24,Oct 22,Nov 16,Dec 20
- Ni-Cd Resistance (QA) Feb 12,(LET)May 12,(LET)Jul 16
- Night-Vision Scopes (Justic & Phillips)(C) Oct 57
- Null Modem (QA) Oct 8

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- Obsolete Semiconductor Sources (Lancaster)(HH) Jun 83
- OS/2 or DOS? (QA) Jun 10
- **Oscilloscope**
  - Book (Lancaster)(HH) Apr 85
  - Portable, Tektronix Tekmeter (ER) Oct 16
  - -to-Vectorscope Converter, Compuvideo (ER) May 16
- Our Automotive Power Supply Comes to Life (Grossblatt)(DB) Feb 82

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- Parallel Processing (QA) Feb 12
- PC I/O Breadboard, Build This (Dage)(C) Jun 51,Jul 55,Aug 59
- PC-Based RF Signal Generator (Doberstein)(C) Mar 35,Apr 61
- Phase-Locked Loops (Marston) Aug 47,Oct 69,Nov 63
- Piano Trainer MicroConductor, The (Tarchinski)(C) Sep 49
- PIC Microcontroller Programmer (Eady) Jan 35,Feb 48

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PLL Section of our Tachometer, The (Grossblatt)(DB) **Jul 80**
Plotter, X-Y (Brown)(C) **May 57**
PostScript Review (Lancaster)(HH) **Aug 77**
Power Amplifiers (Marston) **Apr 65**
Power Line Modem for Home Control (Keefe)(C) **Mar 57**
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Practical Transistor Circuits (Marston) **May 57**
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Pulse Counter (QA) **Jan 10**

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Question of Power, A (Klein)(AUD) **Jan 87**

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  Lost Art of Regeneration, The (Kitchin)(C) **Mar 66,(LET)Jun 14**
  Restore it Right! (McClellan) **Aug 69,(LET)Nov 8**
  Vintage Radio (Knight) **Jan 63,(LET)Apr 12,(LET)Jun 14**
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  Services (Lancaster)(HH) **May 75**
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Santa Claus Machine Update (Lancaster)(HH) **Jul 71**
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  -Effect Generator, Light-Controlled (Canivan)(C) **Sep 65**
  of Digital Compression, The (Klein)(AUD) **Dec 86**
  Pressure Level: Damage/Sonic Realism (Klein)(AUD) **Jul 78**
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    Approach, A Different (Grossblatt)(DB) **Sep 84**
    Our Alternate Takes Off (Grossblatt)(DB) **Oct 86**
  Counting Circuit, Two Possible Designs for our (Grossblatt)(DB) **Jun 29**
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  Audio Wizard Test Generator (Wannamaker)(C) **Apr 41**
  Adjustable Continuity Tester (Kennedy)(C) **Aug 8**
  Analog Signal Troubleshooting (Campbell) **May 69**
  B + K Precision LCR Bridge (ER) **Sep 22**
  Build The Digilyzer (Yacono & Spiwak)(C) **Jun 75**
  Compuvideo Oscilloscope-to-Vectorscope Converter (ER) **May 16**
  Fun With Function Generators (Kral) **Oct 42**
  Hewlett-Packard HP 970 Series Multimeters (ER) **Dec 18**
  ITT Pomona Logic Scope Probe (ER) **Feb 20**
  L-Com DXB65 Ethernet Cable Tester (ER) **Jun 19**
  New Life for Old Scopes (Covington) **Sep 57**
  PC-Based RF Signal Generator (Doberstein)(C) **Mar 35,Apr 61**
  Sweep/Function Generator (Carlson)(C) **Dec 53**
  Tektronix Tekmeter Portable Oscilloscope (ER) **Oct 16**
  Wavetek BDM40 Benchtop Digital Multimeter (ER) **Jul 20**
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  FM Antenna Booster (Smith)(C) **May 49,(LET)Jul 16**
  Shortwave Antenna (Wecke)(C) **Jul 60**
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Two Possible Designs for our Tachometer's Counting Circuit (Grossblatt)(DB) **Jun 29**

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V

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  Amateur TV Station (Sheets & Graf)(C) **Jul 31,Aug 39**
  Driver Circuits (Lancaster)(HH) **Sep 75**
  New Age of Satellite TV, The (Fenton) **Apr 33**
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What is an Operating System? (Holtzman)(CC) **Nov 90**
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Why Build a Tachometer? (Grossblatt)(DB) **Apr 24**
Why Microsoft Will Win and IBM Will Lose the OS War (Holtzman)(CC) **Oct 89**

X

X-Y Plotter (Brown)(C) **May 57**

STINKIN $#
HEMO ✱GLOPEN
NEBBIN //✱?
✱NUZ✱ÄN✱
I'M NOT CURSING MOM... IT'S A NEW COMPUTER LANGUAGE

continued from page 71

components. Make sure that you observe polarities of all semiconductors, SIP resistors, and electrolytic capacitors.

For the prototype, four Triacs were mounted each to two 90° aluminum heatsinks. The AC power input was brought to one heavy-duty, three-terminal connector, and the eight Triac outputs plus AC common were brought to a separate nine-terminal connector.

The circuit board has 120-volt AC signals on it, so check and double-check your work before plugging in and testing the project. Figure 3 is a photo of the author's prototype.

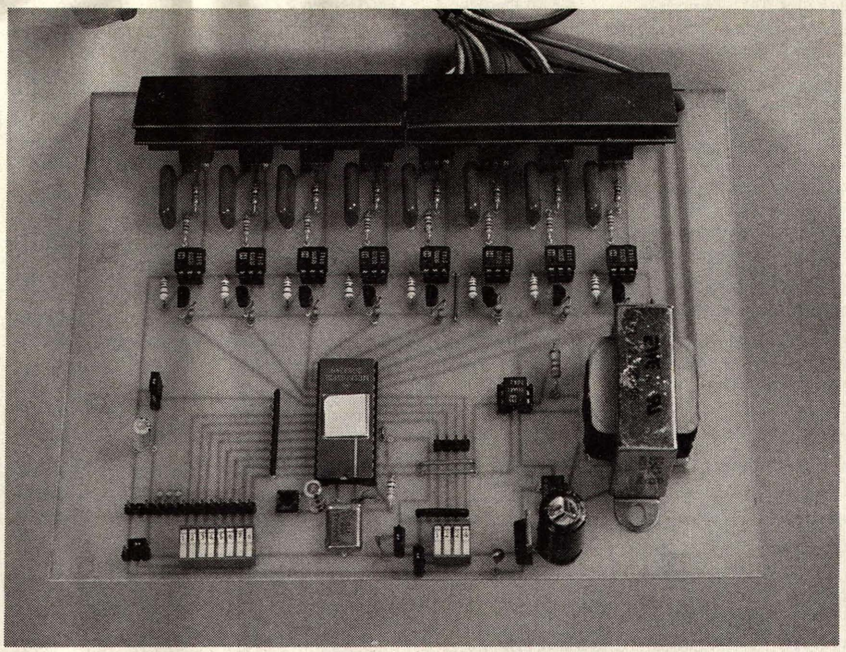


FIG. 3—COMPLETED UNIT. The circuit board has 120-volt AC signals on it, so check and double-check your work before plugging in and testing.

Built-in applications

On power up, a selection routine reads Port C and selects the corresponding application. Note that following power-up, Port C can be used for other purposes. Table 2 lists Port C values, along with the corresponding routines and PC-board jumper settings. In general, if no host is connected and Port A will input data from S1, set the jumpers as shown for application 0 (manual). Also note that in the design, once a routine has been selected, the only way to change to a new routine is to reset the system. Following is a description of each application:

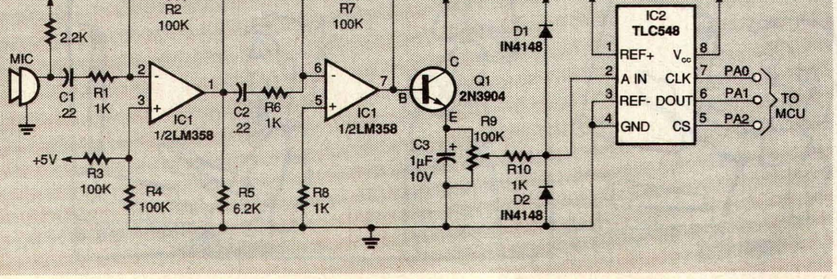
SOUND INPUT

The accompanying schematic shows a simple circuit for letting an audio sound source control the power-controller output. The circuit accepts input from a standard crystal microphone, and amplifies the signal using two op-amp stages. The signal then passes through an emitter-follower circuit that drives a TLC548 A/D converter. Potentiometer R10 functions as a sensitivity control.

The software, presented below, simply clocks the A/D converter eight times, accumulates the result, then stores it in all eight output registers, from where they are applied to the Triacs in the usual manner. To use the routine, you'll have to declare the variable SDDATA, add the routine itself to the jump table, and add a new S1 switch setting to the application-selection power-up routine.

SOUND MODE ROUTINE

```
SOUND:    LDA #$05
          STA DDRA
          BSET 2,PORTA
STARTAD:  CLRA
          LDX #$08
          BCLR 2,PORTA
LOOPAD:   BSET 0,PORTA
          BRSET 1,PORTA,COLLECT
COLLECT:  ROLA
          BCLR 0,PORTA
          DECX
          BNE LOOPAD
          BSET 2,PORTA
          CMP #30
          BHI ADADJUST
STORESD:  STA SDDATA
          BSR APPSD
          BRA STARTAD
ADADJUST: LDA #30
          BRA STORESD
APPSD:    LDA SDDATA
          STA PWRC0
          STA PWRC1
          STA PWRC2
          STA PWRC3
          STA PWRC4
          STA PWRC5
          STA PWRC6
          STA PWRC7
          RTS
```



Manual—The software scans Port A waiting for a bit to go low. When that occurs, the microcontroller loads power-level data from Port C and stores it in the power-control byte specified by the value in Port A. For example, placing 05 on Port C and bringing PA2 low will set output 2 to power level 8. Because Port C has only four input bits, it can only specify 16 power values ($2^4 = 16$). Thus a look-up table (shown in Table 3) spreads the 16 specifiable values across the entire 32-value range.

Sequencer—This routine demonstrates the controller's ability to power light displays. It turns on the first output, waits,

(Continued on page 90)

HARDWARE HACKER

Halogen cycle mysteries, science versus pseudoscience, vector-to-step conversions, a hacker PostScript interface, and programmable interconnects.

DON LANCASTER

I recently reviewed several books that I believe are worth reading. *Who Owns Information?* by Anne Branscomb (Basic Books, 1994) seems to cover everything from the Internet to the Dead Sea Scrolls. It focuses on the new intellectual properties that are challenging traditional copyright laws.

While the book is thorough, it essentially expresses the viewpoint of a conservative lawyer. This book would be far better balanced if it had more input from publications such as the *Free Software Foundation* or *Wired Magazine*.

For a totally different take on a related topic, read Winn Schwartau's *Information Warfare; Chaos on the Electronic Superhighway* (Thunder's Mouth Press, 1994).

I've long been a fan of Richard Feynman, the physicist and gadfly. He was one of my great heros. *No Ordinary Genius: The Illustrated Richard Feynman* has been newly released by Richard Phillips (W. W. Norton, 1994). It's a "life and times of" summary that adds to such titles as James Gleick's *Life and Science of Richard Feynman* (Pantheon, 1992). In addition, read Feinman's own *Surely You're Joking Mr. Feinman* (W.W. Norton, 1985) and *What Do You Care What Other People Think?* (1988).

My other heros? Well, since you asked: Perry Ferrell, Buckminster "Bucky" Fuller, Ed Abbey, P.T. Barnum, and William M. Gaines. I think Gaines was the greatest philosopher of the twentieth century.

Science Versus Pseudoscience? is an important and easy to read Nathan Aaseng book (F. Watts Press, 1994). It clarifies several topics I have kicked around here quite a bit. My own definition of pseudoscience is pretty much one of "looks like a duck, quacks like a duck."

1. Science is logical and rational.
2. Science makes well-defined claims.
3. Scientific hypotheses are falsifiable.
4. Scientific experiments are repeatable.
5. Science requires that claims be examined by peers.
6. Science views unexplained gaps in theories with suspicion.
7. Science requires caution in examining evidence.
8. Science requires objectivity.
9. Science does not accept coincidence as proof.
10. Science does not accept anecodatal evidence as proof.
11. Extraordinary claims demand extraordinary evidence.

FIG. 1—NATHAN AASENG lists these ten key criteria in his *Science Versus Pseudoscience* book. I have added a popular eleventh test here.

When you've been at the research game for a long while, the pseudoscience stuff becomes painfully and laughingly obvious: correspondence like those dreary chain letters that spend five pages telling you they are not chain letters.

Aaseng is much more specific because he lists ten crucial tests to tell the differences between pseudoscience and real science. I've reproduced the list here as Fig. 1. The only thing I'd personally add to his list is "Science requires that extraordinary claims demand extraordinary proof."

A second book with the theme of pseudoscience trashing is *The Hundredth Monkey*, edited by Ken Frazier (Prometheus Books, 1991). It discusses psychic phenomona and related wonderments.

Magnetic Measurements Handbook is a 95-page self-published book by J. M. Janicke and offered by *Magnetic Research*. Included in the book is hard-to-find information on magnetic fundamentals along with a lot of construction projects for fluxmeters, Helmholtz coils, and other similar stuff.

In addition to publishing, Magnetic Research also sells fluxgates and Hall-effect probes. However, the Hall-effect probes are *totally* unsuitable for most compass bearing and navigation applications. The same goes for its abysmal batch of magnetoresistors. Today, a fluxgate compass is the *only* way to go. A competing, low-cost source for fluxgate coils, useful for homebrew compass projects, is *OrthoLogic*. There is more on the subject of electronic compasses in my *Hardware Hacker* reprints.

Vector-to-step conversions

Suppose you want to mill a diagonal cut on a CAD/CAM machine that can step only north-south or east-west. How would you do it? Or suppose you want to show a slanted line on a raster scan display or perhaps on a laser printer's bitmap? Maybe you want to map a tumbling three-dimensional object with animation software?

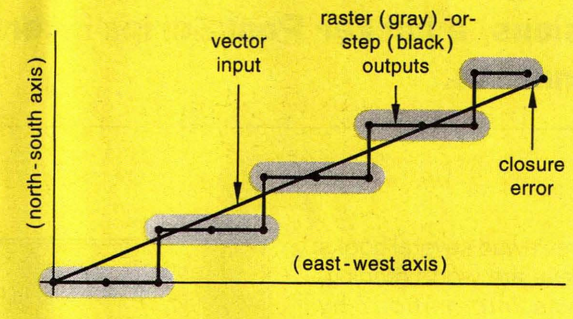
All of these tasks require *vector-to-step* conversions. These are some of the most basic and important requirements in computer graphics. A short review of the fundamentals is given in Fig. 2.

A *vector* is a number that expresses two or more values such as speed and direction. For example, the representation of walking east-northeast (ENE) for 10.2 miles is a vector quantity. Vectors can be *resolved* into their basic components. For instance, by walking 10.2 miles ENE you will arrive at the same place as walking 9.4 miles due east and then walking 3.9 miles due north.

Trigonometry can resolve vectors. As an example, ENE is at an angle of 22.5° counterclockwise from east. By multiplying 10.2 times the cosine of 22.5° you will obtain the 9.4-mile east component. Also, 10.2 times the *sine* of 22.5° gives the 3.9-mile north component.

Obviously, walking the 10.2 mile direct route is shorter and probably a lot easier. A CAD/CAM machine that cuts only east and then travels only north would miss the middle of the path. The trick is to find a set of rules that permit just enough north and east steps to be taken in just the right order to approximate the path as closely as possible.

The goal of vector-to-step conversion is to change a diagonal tool path or a slanty line on a screen or printer bitmap into discrete unit steps that travel only in north-south or east-west directions...



First, you correct your input vector so it starts at your actual initial position. This prevents closure errors from piling up. If not already done, you then resolve your input vector into its *x* and *y* components. For a vector of length Z and an angle of θ...

$$x = Z\cos(\theta) \quad \text{and} \quad y = Z\sin(\theta)$$

Next, calculate the slope *y*/*x* and save it for later use. Then round *x* and *y* off to the nearest integer values to get the actual steps needed. Compare the signs of *x* and *y*, and the abolute sizes of *x* and *y* to find an octant...

x+	*y+*	*x>y*	octant #0	(000 to 045 degrees)
x+	*y+*	*x<y*	octant #1	(045 to 090 degrees)
x-	*y+*	*x<y*	octant #2	(090 to 135 degrees)
x-	*y+*	*x>y*	octant #3	(135 to 180 degrees)
x-	*y-*	*x>y*	octant #4	(180 to 215 degrees)
x-	*y-*	*x<y*	octant #5	(215 to 270 degrees)
x+	*y-*	*x<y*	octant #6	(270 to 315 degrees)
x+	*y-*	*x>y*	octant #7	(315 to 360 degrees)

If you are in octant #0, you always step by *+x* and sometimes step by *+y*. To determine whether a *+y* step is needed, multiply the total number of *x* steps so far by the slope. If the current *y* total is more than 0.5 steps under this value, also add a new y step.

Here are the rules for the other octants...

In octant #0, always step by *+x* and sometimes step by *+y*.
In octant #1, always step by *+y* and sometimes step by *+x*.
In octant #2, always step by *+y* and sometimes step by *-x*.
In octant #3, always step by *-x* and sometimes step by *+y*.

In octant #4, always step by *-x* and sometimes step by *-y*.
In octant #5, always step by *-y* and sometimes step by *-x*.
In octant #6, always step by *-y* and sometimes step by *+x*.
In octant #7, always step by *+x* and sometimes step by *-y*.

For the maximum possible speed, replace on-the-fly calculations by table lookups, compiling, special hardware, or similar techniques.

FIG. 2—VECTOR-TO-STEP CONVERSION is a fundamental tool in computer graphics. Here is how to do it. The details will vary with your end use.

A position in space is said to be *absolute* if it is measured from some 0,0 axis reference point. A position is *relative* if it is measured from the last determined or referred position in space.

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A 10.2-mile straight-line hike is considered absolute if you start from home and end up 10.2 miles from home. Now, suppose that today's hike, part of a week-long trek, lands you 10.2 miles from this morning's start. That's considered to be a relative position. Typically, absolute positioning is used for the first point in any *path*, while relative position is used for all points that follow.

The first step in a vector-to-step conversion is to correct the vector. Typically you want to go from "where you thought you were" to "where you want to be." But you probably are not where you thought you were. Why? Because roundoff errors will change your actual position from your desired position. If you do nothing about these errors, they will accumulate on you. That's one reason why you should take topographical maps with you on a hike.

Instead, you'll *correct* the input vector so that it routes from "where you know you now are" to "where you want to be." This calls for a measurement or else a *transform* from existing device space back into user space. The net result is that the input vector will change slightly in size and direction, thus "swallowing" previous position errors, and correcting on-the-fly.

There are eight possible vector-to-step cases; each can end up "alike but different somehow." Let's call east-west the *x* and north-south the *y* components. Now, *x* could be positive or negative, and *y* could be positive or negative. Moreover, the length of *x* can be greater or less than that of *y*.

The next step is to decide which of the eight cases you have. Then, pick the correct case and use it for the actual conversion. If your computer or microcontroller and the available processing time allows you the luxury of real trigonometry, you could find the *arctan*, or "angle whose tangent is," and then divide by 45 to get a 0 to 7 case.

When speed is essential (or if your microcontroller isn't very powerful), test the signs of *x* and *y* plus the absolute lengths of *x* compared to *y* to pick one of the eight cases. The selected case is then the one that is run.

Assume the math coordinate orientation, rather than the geographical one, with east at 0 degrees, north at 90, west at 180, and southeast at 315°. Then call any of the eight cases an *octant*. A vector of 10.2 miles ENE is in octant *zero*.

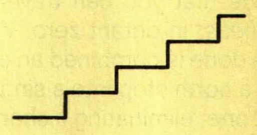
Now, in octant zero, *x* absolutely *must* be positive and absolutely *must* be larger than *y*. Moreover, *y* also *must* be positive. Otherwise, you would be in some other octant. So, in octant zero, simply apply the rule "always step by *x* and *maybe* step by *y*."

Assume that the corrected vector has been resolved into $x = 9.4$ and $y = 3.9$ components. Since you are allowed only whole *integer* steps, you cannot take 9.4 unit steps. In this case, we will *round down* to nine steps. Thus, you want nine *x* steps and you want four *y* steps. The question is when to add the *y* steps to get closest to the original vector.

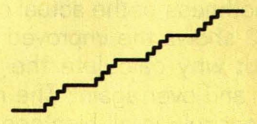
If rounding down gives an *x* value of zero, exit. The little missed piece will be picked up on the next vector. Exiting on a zero length also gets rid of the possible divide-by-zero in the next step.

Next, calculate the *slope* by dividing the little *y* number by the bigger *x* one, or in this case *y/x*. Save this value.

Then step along your *x* axis, always taking one *x* step. After each *x* step, compare the actual *y* against the desired *y* position. The desired *y* position is obtained by multiplying *x* times the slope. Whenever you end



(A) Normal vector-to-step conversion.



(B) With stepper phase interleaving.

FIG. 3—SOME CAD/CAM SYSTEMS can apply *x* and *y* stepper phase by interleaving techniques to improve their apparent resolution dramatically.

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% PostScript Vector-to-step student demo algorithms.

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% Two-way host recordable comm is required.

/curxpos 0 def    /curypos 0 def          % running output currentpoints

/oct0 {2 copy exch dup 0 eq {0.00001 add} if div /slope exch store pop cvi /#incs exch store 0
0 1 #incs 1 sub {/posn exch def (E) print /curxpos curxpos 1 add store posn 1 add slope mul
0.5 sub 1 index ge {1 add (N) print /curypos curypos 1 add store} if} for pop} def

/oct1 {exch 2 copy exch div /slope exch store pop cvi /#incs exch store 0 0 1 #incs 1 sub
{/posn exch def (N) print /curypos curypos 1 add store posn 1 add slope mul 0.5 sub 1 index
ge {1 add (E) print /curxpos curxpos 1 add store} if} for pop} def

/oct2 {exch 2 copy exch div neg /slope exch store pop cvi /#incs exch store 0 0 1 #incs 1 sub
{/posn exch def (N) print /curypos curypos 1 add store posn 1 add slope mul 0.5 sub 1 index
ge {1 add (W) print /curxpos curxpos 1 sub store} if} for pop} def

/oct3 {2 copy exch div neg /slope exch store pop cvi abs /#incs exch store 0 0 1 #incs 1 sub
{/posn exch def (W) print /curxpos curxpos 1 sub store posn 1 add slope mul 0.5 sub 1 index
ge {1 add (N) print /curypos curypos 1 add store} if} for pop} def

/oct4 {2 copy exch div /slope exch store pop cvi abs /#incs exch store 0 0 1 #incs 1 sub
{/posn exch def (W) print /curxpos curxpos 1 sub store posn 1 add slope mul 0.5 sub 1 index
ge {1 add (S) print /curypos curypos 1 sub store} if} for pop} def

/oct5 {2 copy div /slope exch store cvi abs /#incs exch store pop 0 0 1 #incs 1 sub {/posn
exch def (S) print /curypos curypos 1 sub store posn 1 add slope mul 0.5 sub 1 index ge {1
add (W) print /curxpos curxpos 1 sub store} if} for pop} def

/oct6 {2 copy div neg /slope exch store cvi abs /#incs exch store pop 0 0 1 #incs 1 sub {/posn
exch def (S) print /curypos curypos 1 sub store posn 1 add slope mul 0.5 sub 1 index ge {1
add (E) print /curxpos curxpos 1 add store} if} for pop} def

/oct7 {2 copy exch div neg /slope exch store pop cvi abs /#incs exch store 0 0 1 #incs 1 sub
{/posn exch def (E) print /curxpos curxpos 1 add store posn 1 add slope mul 0.5 sub 1 index
ge {1 add (S) print /curypos curypos 1 sub store} if} for pop} def

/findoctant {2 copy exch 2 copy 0 eq exch 0 eq or {pop 0.000001} if atan cvi 45 idiv
[{oct0}{oct1}{oct2}{oct3}{oct4}{oct5}{oct6}{oct7}{oct0}] exch get} def

/vectortostep {findoctant exec flush } def    % main control loop

%  ///// demo - remove or alter before reuse /////

9.4 3.9 vectortostep quit      % should return EENEENEENEENE
```

FIG. 4—A STEP-TO-VECTOR CONVERTER written in PostScript.

up more than half a step (or 0.5) low, add a *y* step. Continue this for each needed *x* step. That's all there is to this.

To review: For any vector-to-step conversion, first correct the vector so it travels from where you really are to where you want to be. Then pick one of eight octants, based on the size and sign of the *x* and *y* components. Then pick an octant-specific code that always steps along *x* but only sometimes steps along *y*, or vice versa.

Getting fancy

There are several refinements that can be added here. Testing for a 0.5 unit error becomes less accurate the steeper the vector gets. But 0.5 is more than satisfactory for most applications. For the best fit, use 0.5 times the *cosine* of the slant angle.

If you can't "afford" a real cosine, 1 − (angle in radians)^2/2 could substitute for it pretty well. Cruder useful substitutions are 0.5 − (angle in degrees)/300. Or you could even let 0.44 split the difference.

Some CAD/CAM applications will let you move your *x* and *y* steppers simultaneously. This is called *stepper phase interleaving*. It means that you can travel *east* or *northeast* in octant zero. What you have done is combined an east step with a north step into a single northeast one, eliminating a sharp corner in the process. That dramatically improves the resolution, speed, and smoothness of the actual cuts. Figure 3 shows the improved results.

But why calculate the obvious over and over again? The most important rule in all high-speed computing is to avoid calculating what you can look up! Any of several *table lookup* techniques can dramatically speed things up. But these are hard to understand and are very device-specific.

A PostScript example

There are all kinds of variations on these vector-to-step schemes. It all depends on how fast you want to be and whether your microprocessor is capable of performing trigonometry rapidly.

In some cases (such as computer animation), the rendering speed is everything, and you must use every machine language trick possible to make things happen quickly. Elsewhere (such as computer-aided design), a more leisurely pace is acceptable, and a powerful and friendly higher-level language works just fine.

I have found the general purpose *PostScript* computing language to be ideal for medium-speed conversions, especially for real-time CAD/CAM. Figure 4 shows PostScript code that can do these conversions for you. This is a very simple tutorial example that can be (and has been) significantly improved.

With table-lookup code, speeds in the 13,000-steps-per-second range are easily reached. Results can be recorded and then sent out later at arbitrarily high speeds.

The key point here is that you can now easily apply PostScript to ultra-low-cost homebrew hacker applications; it is much better than any other way I know of. It is particularly good for such tricks as microsizing and compensating for tool paths and diameters.

How can you use PostScript's graceful curves and fancy lettering? Curves are simply broken down into a lot of individual straight-line vectors which are short enough to meet your accuracy goals. PostScript's *charpath* and *flattenpath* operators are used for curve-to-vector conversions.

More examples of vector-to-step conversions are given in my POSTVECT.PS, FLUTWUMP.PS and FLUTOOLS.PS on *GEnie* PSRT. I've also got some exciting new products in the works that are based on these concepts. Give me a call if you need advanced details or help with your own project.

The halogen cycle

I've received several helpline calls about early fusion lamp failures on

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Canon EX laser engines, such as the 4M+ or Pro630. The symptom of the failure is a darkening of the bulb before it burns out. Well, I have some theories here...

A quartz halogen lamp located inside the bottom roller intermittently turns on and off. It heats the roller to a regulated 375° F temperature.

Despite the fancy name, a quartz halogen lamp is still fundamentally an incandescent bulb with a more or less ordinary tungsten filament. The only difference between them is that the halogen lamp is run much hotter for higher efficiency. The quartz bulb is more resistant to heat shock than ordinary glass. Some wondrously magic chemistry known as the *halogen cycle* presumably makes the filament last longer.

Tungsten readily forms compounds with halogen gases such as chlorine and fluorine: examples are tungsten hexachloride or tungsten hexaflouride. These gases are stable at lower temperatures, but dissociate at very high temperatures.

Now, one big shortcomming of high-temperature filament life is that the tungsten literally boils off. This both weakens the filament and blackens the glass, leading to early lamp failure.

Here is how the halogen cycle works: Near the hot filament, ejected tungsten mixes with the dissociated halogen. Away from the hot filament, the two substances merge to form a stable halide gas. When the lamp is turned off, much of the dissociated tungsten redeposits back on the filament. Normally, there is little opportunity for bulb darkening.

However, there are two important rules for quartz halide lamps: *Never touch them!* and *Always cool them completely!* Fingerprints can cause a high-temperature spot on the glass, leading to mechanical stress and a possible darkening. Moreover, a cooling-off period is mandatory for the halogen cycle to complete itself.

Consequently, there might be a quality control problem. Or maybe somebody who doesn't know better is handling the lamps during assembly or service. But I have the following hunch: That "green" lower energy operation of new laser printers is dead wrong for the halogen cycle. The worst thing you can do to a quartz halogen lamp is to cycle it repeatedly.

Here are some possible solutions: Run the lamp continuously for an hour every now and then, outside of the printer (perhaps even at 120% of rated voltage). See if that

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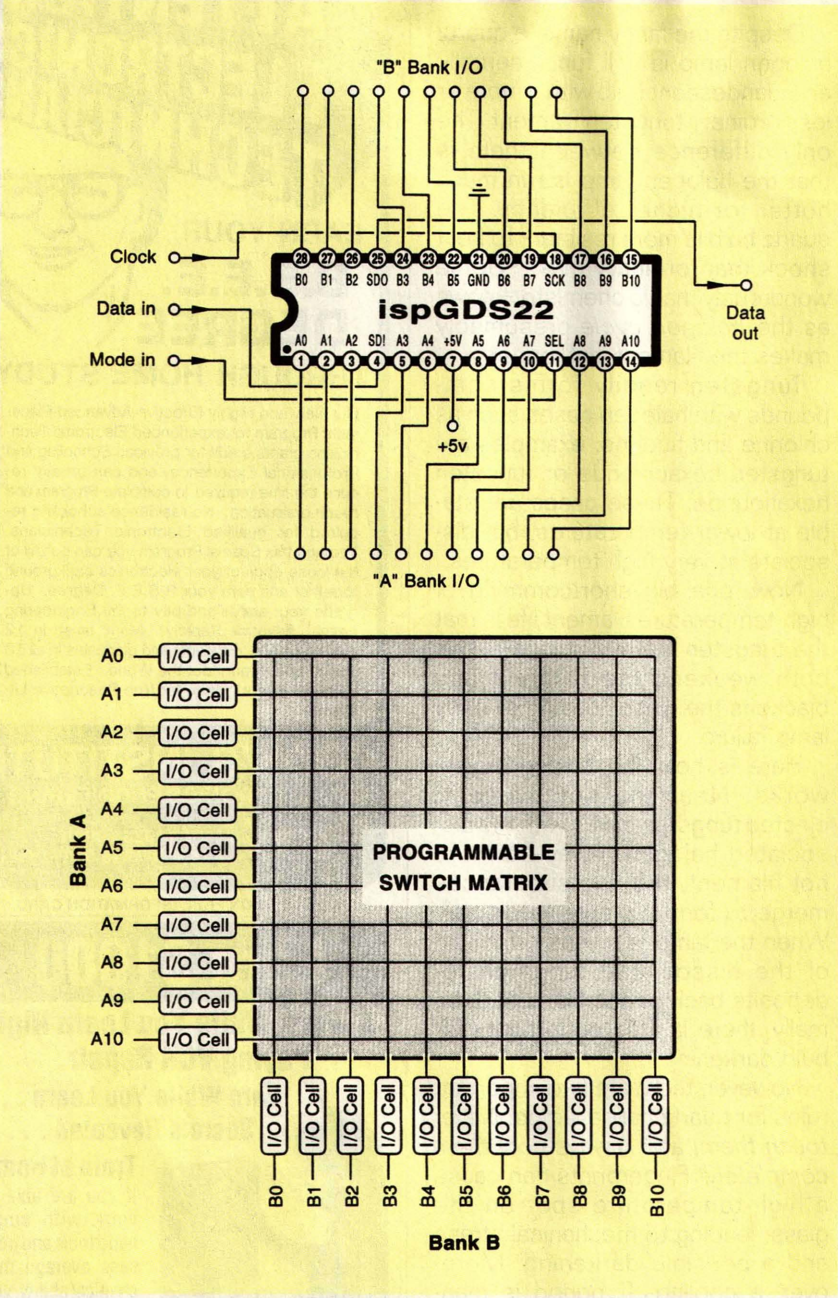

FIG. 5—A GENERIC DIGITAL SWITCH from Lattice Semiconductor offers medium-density programmable interconnects.

lightens it up any. Do this in a room where a kilowatt of heat can be safely dissipated. And, of course, *keep fingerprints away!*

Other solutions are to design a new lamp technology specifically for the new "green" energy cycles, or go to some type of PTC self-regulation.

Programmable interconnects

The next logical progression beyond programmable integrated circuits is fully *programmable systems* in which all of the conductors between ICs can be conveniently and quickly rearranged. Obvious uses that come to mind are for breadboarding, development, and field upgrades.

An ideal interconnect would be dense and cheap, allowing arbitrary connection of any function anywhere. Connections would permit analog or digital signals to move out in either direction without delays.

Both the "on" resistance and any crosstalk would be very low, and these devices should consume little or no power. They would have to "remember" all their connections between powerdowns and be fully reprogrammable at any time.

As you might imagine, the semiconductor houses are scrambling to offer new programmable interconnect devices. I have listed the key players in this month's resource sidebar.

Unfortunately, nearly all devices offered today miss on one or more objectives. *Aptix* seems to be at the top of the heap. Its devices are quite dense, extremely flexible, bi-directional analog/digital, and have low "on" resistance and crosstalk. But they are expensive and have to be reprogrammed each time power is applied to the system.

Pioneer and *Quality* offer very low cost and easy to use bi-directional bus switches, but their density is very low. Programming is external. *Atesla* has arrays of direct interconnects with blowable fuses. They are medium low-cost items that offer bi-directional analog/digital operation. But once blown, the results are permanent and programming cannot be changed.

Apparently, those programmable logic device manufacturers are relabeling their existing PLA and PLD variations so that they can claim they are interconnects. While dense, reprogrammable, and low priced, the functions are often digital only and one-way only. There are also propagation delays to consider.

One brand new source is *Lattice Semiconductor* with its *Generic Digital Switch*, shown in Fig. 5. Densities up to 11 × 11 are offered. Any lead can be "taught" to be an input or a three-state digital output that can be its input, the complement of its input, a one, or a zero. The devices are reprogrammable. But an A-side input/output can only be routed to B-side pins. These devices are ideal as DIP-packaged switch replacements.

Meanwhile, *I-Cube* is offering FPID devices, short for *Field Programmable Interconnect Devices*. While essentially PLD-style devices, those also provide for high-impedance analog applications.

Crossbar architecture is available with densities as high as 320 × 320. Since this is static-RAM

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based, it must be retaught every time power is turned off. Each pin can be taught to have eight different functions and each pin can be non-buffered for analog signal pass-through. Digital inputs can be buffered or latched. Outputs can be buffered, registered, or held either high or low.

Information on newer devices likely to overcome all of the obvious defects of this current crop of products should show up in the usual electronics publications such as *E.E. Times*, *EDN*, *Electronic Design*, *Electronic Component News*, and in *Electronic Products*.

Let's have your thoughts on new hacker applications for these exciting parts. The usual *Incredible Secret Money Machine II* book rewards for your contributions.

New tech lit

Motorola has a new *Master Selection Guide*. One unique new IC is the MC144143 TV closed-caption decoder.

Tektronix has a number of videos and application notes that you might be interested in. One video is on The VectorScope, a crucial instrument for color TV broadcasting and video production. There's also a pair of videos on cable measurement, plus others on such specialized top-

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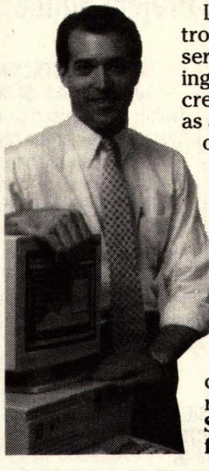

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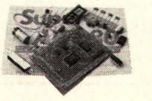

*This expansion kit upgrades the PIO of the AKI-80 (64 parts)
*Max. 232 mounting capacity (enables use of on-board RS-232C interface)
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*Ultra-compact Z80 microcomputer board featuring high-speed operation at 12 MHz
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BU4986-AR (Stanley)
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•Welcon 28P ZIF Sockets
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ics as cable TV sweep systems. Of their many offerings, you might also find their application note on spectrum analyzers to be handy.

Real live human neurons are now offered by *Stratagene* according to its inside cover ad in the September 2, 1994 issue of *Science*. If I understand this ad correctly, these neurons can be hot wired for direct electrical to biological neuron computing experiments.

Three good weather satellite resources are *MultiFAX*, *Accu-Weather*, and *ZFX*.

Harris Publishing has a new 1995 *Electronic Industry Telephone Directory*. If it is not already in my *Synergetics Master List*, the EITD is the reference I'll always check first.

Access to Energy is a labor-of-love publishing venture that bills itself as a high-tech, free enterprize, monthly newsletter.

A freebie *Sil-Pad Sample Kit* from *Bergquist* includes several thermally conductive insulators. These insulators are intended for use in the heatsinking of power semiconductors.

A free issue of the *Seismo Watch Newsletter* is available. The publication is a source of weekly earthquake information.

The *Extraordinary Science 1995 Resource Guide* is a new catalog of both real science and pseudoscience books, videos, and reprints. Among other strengths, the guide lists a definitive Tesla collection. The publisher is now stocking a lot of the *Lindsay Publications* texts.

A well done catalog of architectural Griffins and Gargoyles is newly available from *Design Toscano*.

For the fundamentals of digital integrated circuits, check into my classic *TTL Cookbook* and my *CMOS Cookbook* texts. More details appear in my nearby *Synergetics* ad.

I also want to remind readers that reprints and preprints of all my columns, my free insider secrets catalogs, and instant technical help is available on *Genie* PSRT. A ten-hour free trial is available per the *Need Help?* box.

Free catalog requests and technical questions you want answered here or on PSRT can also be sent to me at my SYNERGETICS@GENIE.GEIS.COM Internet address. Ω

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AUDIO UPDATE

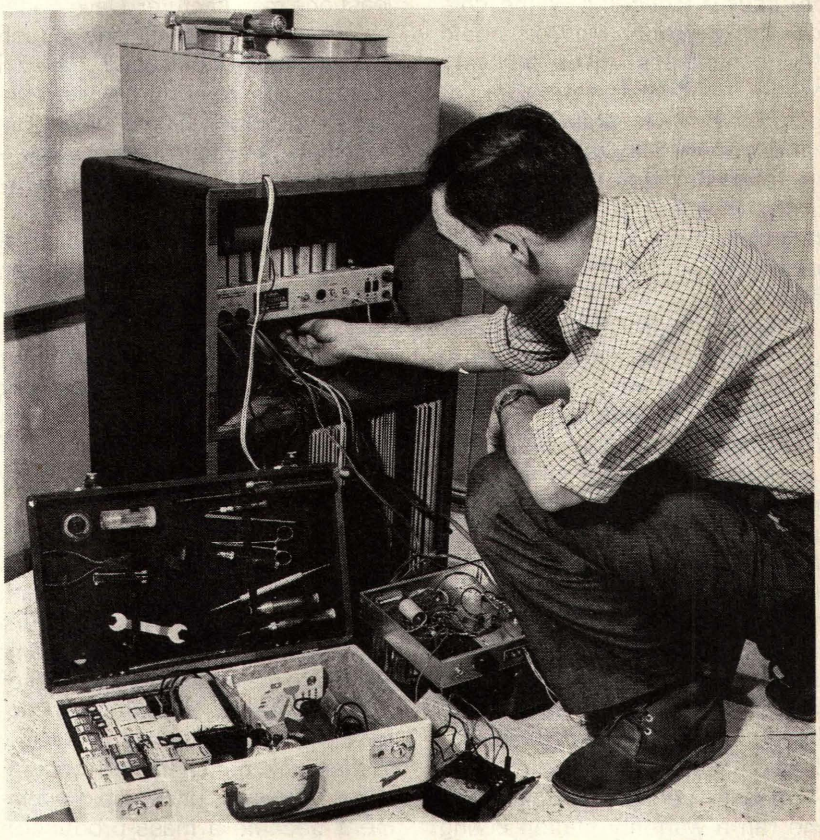
Getting a quick fix, or service with a smile.

LARRY KLEIN

As with many other boys, it all started for me when I was about 13 years old. Not sex, electronics. Hours of immersion in The Boy Electrician, Everybody's Radio Manual, and Radiocraft ultimately led me to apply for an after-school apprenticeship at a local radio repair shop. I'm sure that I got the job as a result of the World War II home-front manpower shortage rather than any precocious electronic know-how. But in any case, 50-odd years later I still remember an incident from my first day of work.

I was told to check out a five-tube, table model radio. It seemed O.K. for the first few minutes after warm-up, but then the output began to distort. My boss, who was working on something else, glanced at the radio and said: "Change the leaky 0.01 condenser between the plate of the 12SQ7 and grid of the 50L6."

I was stunned! How did he know what needed changing—or even what tubes were in the set? I vowed that one day I too would be the proud possessor of such arcane knowledge. And, by the time I joined the Army in 1946, I was so proficient in the electronic mysteries that I was sent to White Sands Proving Grounds to be an electronics technician during the start-up of the U.S. space program—but that's another story.



Young Larry Klein on a service call. Note the tubes and tools in the attache case service kit.

Post-service servicing

My career as a service technician continued after the Army. After several jobs with local car- and home-radio repair shops, I found myself repairing test and hi-fi equipment for the Electronic Instrument Company (EICO) during the day, attending college in the evenings, and freelancing hi-fi repairs over the weekends. This went for five years or so until I traded in my soldering iron for the proverbial blue pencil and became the technical editor of Popular Electronics. (One might say that I went from repairing electronic equipment to fixing electronics prose...but perhaps not.)

During the time I've been in publishing I've witnessed the advent of the transistor, the IC, and the slow demise of tube electronics. From a very personal point of view, the virtual takeover by solid-state electronics has somewhat saddened me. It's not that I found something romantic in the soft glow and warmth of tube equipment, it's just that when something went wrong I could fix the damned thing! (I suspect that I now enjoy repairing old tube radios from yard sales and thrift shops mainly to offset lurking feelings of electronic impotence.)

My slow transition from Mr. Fixit to a normally incompetent electronics consumer was painful, but inevitable. As we all know, electronic technology is in such a state of rapid change that, like the situation with Alice's Red Queen, "It takes all the running you can do to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that." Although I've hung up my Nike Airs, I can usually follow complex descriptions of new technologies—but please don't ask me to troubleshoot the products!

Manufacturers' warranties

When I first became involved in

audio in the Fifties, there were some strange ground rules embedded in manufacturers' warranties. It seems that the stores that sold hi-fi products were not allowed to do in-warranty repairs on them. For that, there were "factory authorized" warranty stations (which usually had contracts with several major companies) and, of course, the factory itself. I wondered at the time how the warranty stations could stay in business, given the very meager fixed-labor rate paid for each repair. It was explained to me that out-of-warranty repairs, including referrals from the manufacturers, made the difference—particularly since warranties usually were in force no longer than 90 days.

When transistor equipment appeared, many, if not most, electronic manufacturers optimistically extended their warranties to a year. A bad mistake, as it turned out. The transistors blew up, broke down, and sometimes fell out of their sockets during shipment. Yes, small-signal semiconductors were plugged into sockets because (1) they didn't stand up well to soldering heat, (2) the manufacturer was unsure about their reliability, and (3) they sometimes needed to be changed during component assembly and final test.

I recently spoke to an old friend who ran a warranty station during this transition period. He asserted that transistor problems not only caused the demise of many warranty stations—including his own—but also drove several hi-fi companies into deep financial trouble.

Aside from the arguments pro and con about transistor sound quality in the hi-fi magazines, the main consumer concern was equipment reliability. Knowing this, at least one manufacturer, Dave Hafler of Dynaco, held off joining the rush to solid state for at least a year until his products were, in his view, virtually bulletproof. Guess what? His amplifiers ran into trouble anyway—including the two that blew up in my living room.

Several years went by before a combination of better circuit design and improved semiconductors' finally resolved the reliability question. Although today's equipment still breaks down for one reason or another, anyone who grew up with vacuum tubes is very much aware of the enormously improved reliability of solid-state components.

Today's complaints

During the very early days of hi-fi when I was doing my after-hours service work, no one ever complained to me about the high cost of repairs. After all, I was the hi-fi doctor bringing my curative know-how to their sick, but cherished, components. However, once audio equipment became a mass-production commodity, the audio repairman suddenly had no more status than the TV repairman—and might even have been the same person.

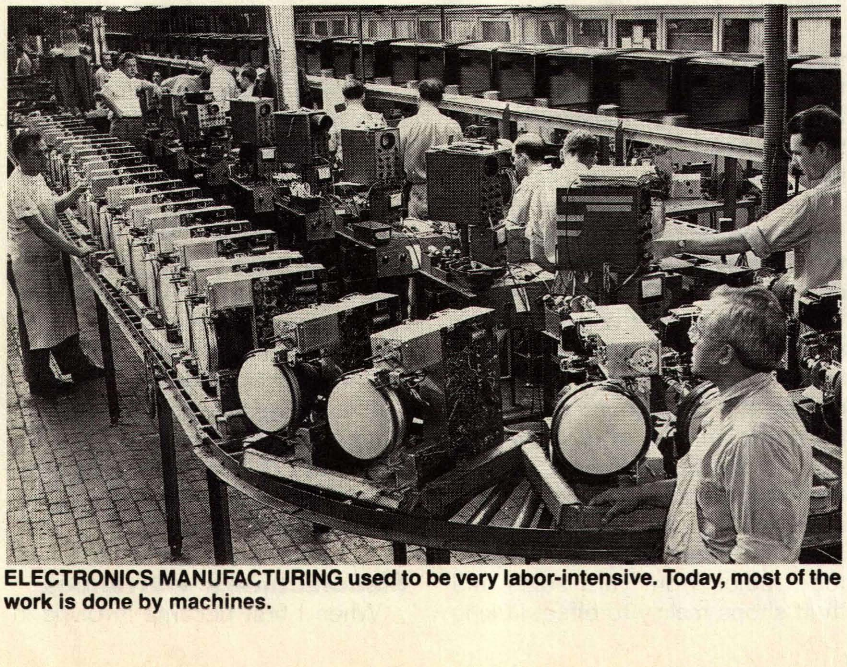
I've written several times that the high cost of a repair compared to the original product price is an inevitable result of modern manufacturing technology. To put it simply: Products are built by efficient, computerized, automated assembly lines, but they are repaired by the equivalent of 19th-century hand labor. For that reason, a skilled technician could easily put in $25 or more worth of labor to repair a $50 radio.

I've always held that the manufacturer was the best source for making repairs, whether in warranty or not. But I've noticed that some major hi-fi manufacturers now refer you to outside service organizations for repairs on their products. I'm not sure whether this results from downsizing, a desire to avoid the onus of repair problems, or in some other way reflects the currently problem-beset audio market, but the existing fact of life is that many manufacturers don't seem to want to do in-house repairs.

The Shack solution

Radio Shack for years has had a well established in-house repair service to handle its own exceptionally wide range of electronic products. Seeing an opportunity to bring a nationally known and responsible company name to an enterprise that strikes many consumers as a stress-inducing caveat-emptor situation, Radio Shack has apparently committed itself wholeheartedly to the consumer-electronics repair business. The "Repair Shop" at most Radio Shacks will handle more than 40 brands of equipment with the usual cost of repair ranging from $50 to $75.

In truth, I don't fully understand the economics of the situation from Radio Shack's point of view, but the company president estimates that the new repair business could generate $500 million a year by 1999. Their prospects seem favorable. According to the U.S. Commerce Department, consumers spent a total of $3.8 billion last year getting their electronic goodies fixed. And I find it embarrassing that I contributed my pittance to that pot. Ω



ELECTRONICS MANUFACTURING used to be very labor-intensive. Today, most of the work is done by machines.

DRAWING BOARD

Converting spark count to engine RPM.

ROBERT GROSSBLATT

It's been a long time coming but we're down to the last leg in the design of the tachometer. At this point, some arithmetic must be done, and here's where the job can get tedious.

The output of the latest circuit (see November 1994) is the number of sparks produced by an engine every three seconds. The following formula converts that to revolutions per minute:

rev./min. = sparks/sec. × rev./spark × sec./min.

The first part of the expression is related to the number available at the output of the circuit, the second part is related to the size of the engine, and the last part is just standard conversion. If you simplify the expression and use "N" as the number of sparks per revolution for a particular engine, you wind up with a description of the arithmetic that you have to do:

RPM = ((circuit count) × 20)/N

There are two arithmetic operations to perform. One is to multiply the count delivered at the multiplexed output bus of the 4508s by 20 (60 seconds/3 seconds of sparks), and the other is to divide the spark count by a factor dependent on the size of the engine. There are many ways to do this; a bit of forethought can help you find the easiest.

If you were to do the multiplication first, you would have to deal with some awkwardly large numbers. For example, a 12-cylinder engine running at 6000 rpm produces 1800 sparks per second. Multiplying that by 20 means you'll need a circuit that can handle 36,000 decimal—that's 1000 1100 1010 0000 binary. Sixteen data bits are difficult to deal with.

The numbers that you have to work with will be much more manageable if the division is done first. The question is, where should the division be done? Doing it after the 4508s might seem logical, but it would require too much extra circuitry. An easy place to do the division is right on the clock line feeding the 4040 counters.

Since the largest value you'll have for N is 6 (for a 12-cylinder engine), you can do the division with a 4017 decade counter and a bunch of jumpers as shown in Fig. 1. When the PC board is laid out, jumpers can be added to configure the tachometer circuit for engines with different numbers of cylinders.

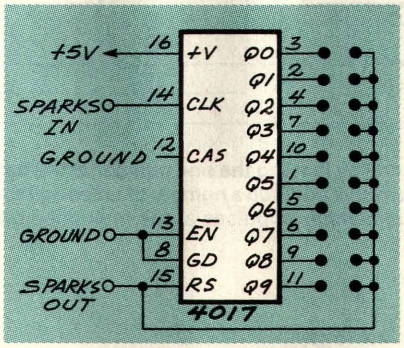


FIG. 1—DIVISION IS DONE by a 4017 decade counter. The jumpers can configure the tachometer circuit for engines with different numbers of cylinders.

The most straightforward way to handle the multiplication operation is with a rate multiplier. The 4089 is a CMOS binary rate multiplier that is perfectly suited for the required multiplication. The pinout of the chip is shown in Fig. 2.

When a clock signal is fed to pin 9 of the 4089 with most of the control pins grounded, and a binary number is placed on the data inputs, the chip will have two different outputs. The first output is the BASE RATE and the second is the MULTIPLIED RATE. The relationship between the two outputs makes the chip perfect for the tachometer application. For each pulse that is output at the BASE RATE pin, a number of pulses equal to the binary number preloaded at the data inputs are produced at the MULTIPLIED RATE pin.

To multiply two numbers (X and Y) with a rate multiplier, present one of them to the data inputs before the clock is started. Then keep track of both the base rate and the multiplied rate to get your answer. The rate

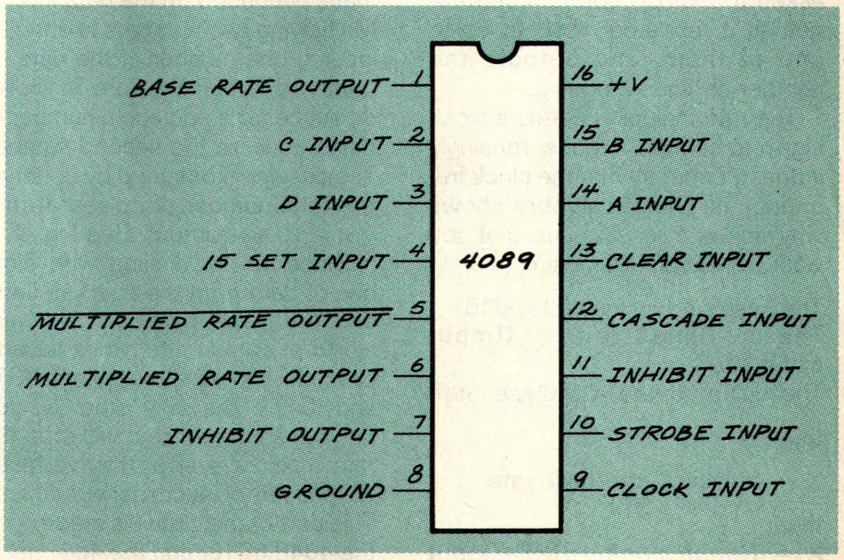


FIG. 2—4089 RATE MULTIPLIER pinouts.

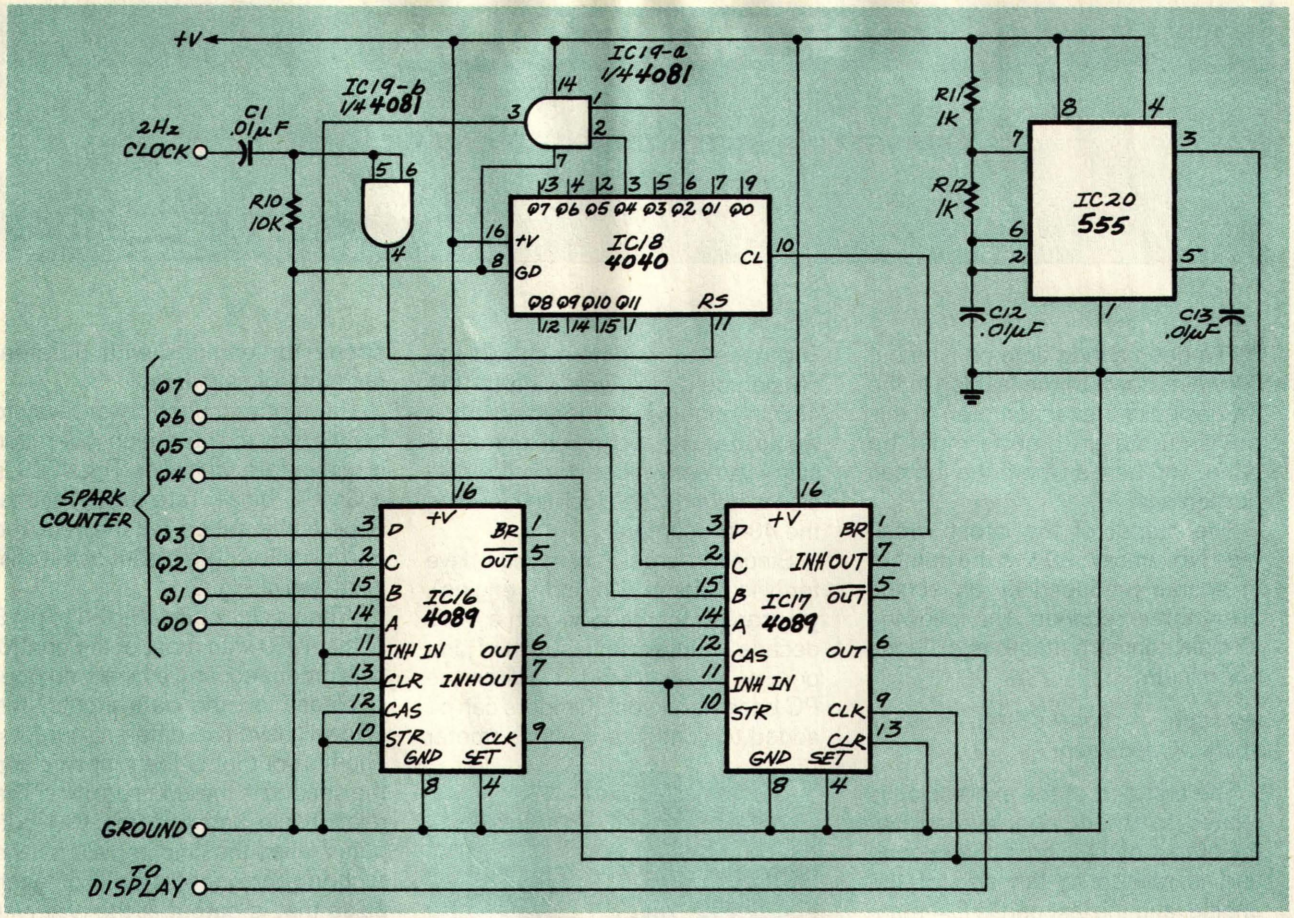

+V
IC19-a
1/4 4081
IC19-b
1/4 4081
2Hz
CLOCK
C1
.01µF
R10
10K
IC18
4040
Q7 Q6 Q5 Q4 Q3 Q2 Q1 Q0
+V
GD
CL
Q8 Q9 Q10 Q11
RS
R11
1K
R12
1K
IC20
555
C12
.01µF
C13
.01µF
SPARK
COUNTER
Q7
Q6
Q5
Q4
Q3
Q2
Q1
Q0
IC16
4089
D
C
B
A
INH IN
CLR
CAS
STR
+V
BR
OUT
OUT
INHOUT
CLK
GND
SET
IC17
4089
D
C
B
A
CAS
INH IN
STR
+V
BR
INH OUT
OUT
OUT
CLK
CLR
GND
SET
GROUND
TO
DISPLAY

FIG. 3—MULTIPLYING TWO NUMBERS is done by loading the one number at the data inputs and letting the rate multiplier do successive addition a number of times equal to the second number. The answer is the total number of pulses at the multiplied rate output.

multiplier does that by counting up to X repeatedly at the multiplied output rate, and it indicates how often it's doing it at the BASE RATE output. The rate multiplier is really doing successive addition. When it is asked to multiply two numbers together, it repeatedly counts up to one of them, and outputs the number of times it does it.

The rate multiplier needs a clock signal to operate it, but surprisingly it doesn't matter what the clock frequency is. Simple algebra shows why this is true. Assume that you want to multiply X times Y:

The base rate = input clock/16
The multiplied rate = ((input clock/16)X)
The multiplied rate = (X(base rate))

thus:

X = multiplied rate/base rate

thus:

X = (input clock/16)X))/(input clock/16)

or

X = X

The only number that affects how many of pulses appear at the MULTIPLIED RATE output is the number that's preloaded on the data inputs. Multiplying two numbers is done by loading one number at the data inputs and letting the rate multiplier do successive addition a number of times equal to the second number. The answer is obtained by counting the total number of pulses at the MULTIPLIED RATE output. See Fig. 3.

Since you're dealing with eight bits of data from the spark counter and the 4089 has only four bits worth of data inputs, you'll have to cascade two rate multipliers (IC16 and IC17). The only other IC you need is a counter that will stop the rate multipliers after they've made 20 passes of successive addition. This part of the circuit is made up of the 4040 (IC18) and the 4081 quad AND gate (IC19).

The 4040 counts the number of 4089 BASE RATE output pulses and when the count reaches 20, AND gate IC19-a detects the count and puts a high on the 4089's inhibit inputs to stop pulses from appearing at the MULTIPLIED RATE output.

One control signal is still missing, however. The AND gate stops the rate multipliers from working after multiplying the spark count by 20, but you need some way to restart the multipliers when a new count appears at the outputs of the spark counter.

This problem is solved by the 4040's RESET pin (pin 11). Every time a new spark count is ready to be multiplied, the two-hertz clock outputs a pulse that controls the 4040's RESET pin. As you can see in Fig. 3, the two-hertz clock signal is delayed by a half monostable circuit made up of a 4081 AND gate (IC19-b), and this delayed signal triggers the 4040's RESET pin. The RC values in the half monostable circuit ensure that the 4040 won't be reset until the correct count is available at the output of the spark counter. Ω

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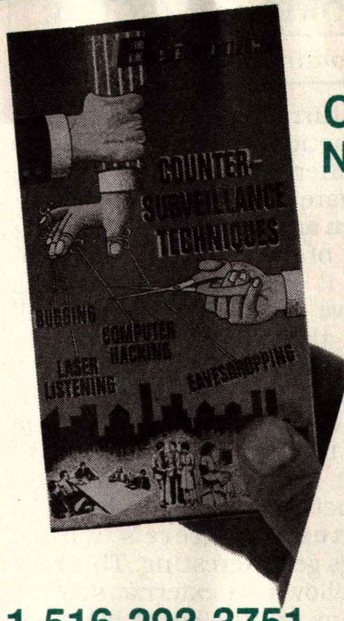

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The professional is not without his tools. Special equipment has been designed so that the professional can sweep a room so that he can detect voice-activated (VOX) and remote-activated bugs. Some of this equipment can be operated by novices, others require a trained countersurveillance professional.

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This advertisement was not written by a countersurveillance professional, but by a beginner whose only experience came from viewing the video tape in the privacy of his home. After you review the video carefully and understand its contents, you have taken the first important step in either acquiring professional help with your surveillance problems, or you may very well consider a career as a countersurveillance professional.

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VIDEO NEWS

continued from page 34

leave a message at the tone." Transmitted messages or pictures are automatically recorded on the Viewcam's Hi8 cassette, which permits up to two hours of audio or video information.

The system uses JPEG (Joint Photographic Experts Group) standards, has compression ratios of 20-, 15-, and 8-to-1, depending on the transmission speed; has a screen resolution of 384 × 240 pixels; and transmits images at 9600, 7200, 4800, and 2400 baud. Sharp thinks it will find many uses in business, where it's necessary to transmit detailed color images, as well as for personal use (sending baby pictures to Grandma, etc.).

The system isn't exactly cheap—the camcorder lists at $2500, the teleport at $900. And, of course, it takes two to tango. Ω

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POWER CONTROLLER

continued from page 76

then turns it off. It then repeats that action for output 2, and so on. After output 7 toggles, the software then repeats the cycle.

Run and flash—This is a variation of the sequencer application. It sequences the outputs for five cycles, then flashes all eight three times and repeats the cycle.

Test—The test application tests the controller. The routine steps the outputs through all 32 power levels, pausing one second between each.

External—Here's where things get interesting. This routine allows an external source, such as an intelligent I/O module or a computer, to control power levels. To get into this mode, set switch S2 to a value of 2, install the correct jumpers, then reset the circuit. From then on, input Port C0 functions as a strobe that causes the microcontroller to read the value on Port A and perform the proper function.

When PC0 goes low, the microcontroller reads Port A. It then splits the value into a 5-bit power specification (PA0–PA4), and a 3-bit output port (PA5–PA7). The 5-bit power specification allows 1 of 32 values; the 3-bit output port allows 1 of 8 ports.

For example, assume you place the value $57 on Port A and strobe PC0 low. In binary, $57 = 0101 0111. Taking the upper three bits yields 010, or 2. Taking the lower 5 bits yields 10111, or 23. Thus the controller will set output 2 to level 23.

Summing up

As you can see, both hardware and software are simple and suitable for being customized. For example, you could connect the output of an A/D converter to Port A, then vary power levels based on some analog quantity.

When creating your own routines, be sure to include it in both the power-on Select routine and the Jump Table. That way the controller will know where to find it. Ω

SIGNAL THEFT

continued from page 40

cian and enter competitions.

By 1996, it is estimated that the U.S. market for digital cable converters will reach 4.5 million units annually, as cable companies upgrade the 65 million converter boxes now in use. The new converters—in conjunction with digital compression and fiberoptic cable—will expand the television's receiving capacity to perhaps as many as 500 channels.

Numerous joint ventures are underway to develop a new converter, and the result is that several types of converters will be on the market. Among the projects in progress: Hewlett-Packard is building a radio-based system. Intel, Microsoft, and General Instrument are creating a cable box based on Intel's microprocessors and GI's digital compression technology. Scientific Atlanta is building digital terminals for Time Warner's Full Service Network and U.S. West's video dialtone trial.

There is an industry-wide requirement for adequate signal security. A pirate who develops the technology to intercept a digitally compressed signal might be able to access a person's bank account, ATM number, and phone number, as well as other personal information.

The starting point for the scrambling that will be used for interactive television is the encryption already in use for digitally transmitted signals. Those transmitted signals are already in limited use by several programmers such as HBO.

Interactive television promises to be a revolution in television viewing. By any account it will be a boon to the cable industry and generally to the electronics industry. Reaping the full benefits of this technology will be no small feat. Signal theft will be one of the major obstacles. Not only will a foolproof encryption standard have to be developed, but intra-industry security must be carried out along with a uniform policy for marketing and distribution. Ω

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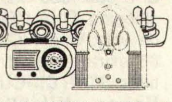

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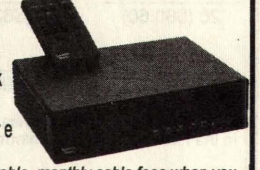

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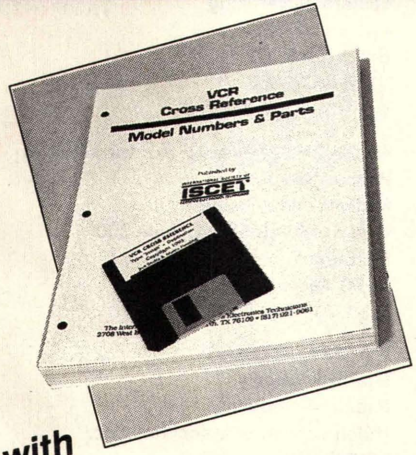

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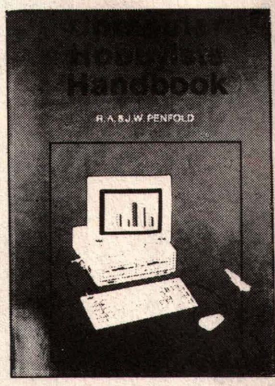
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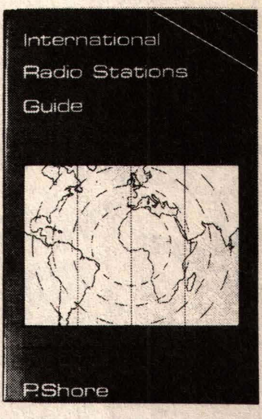
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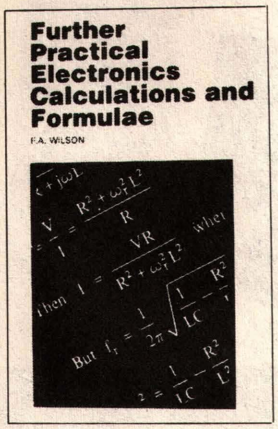
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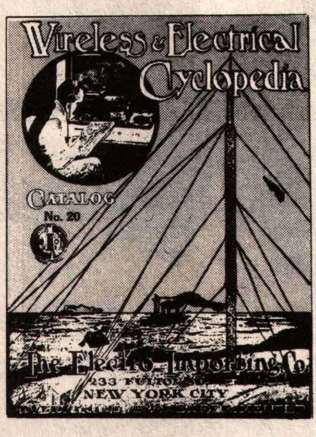
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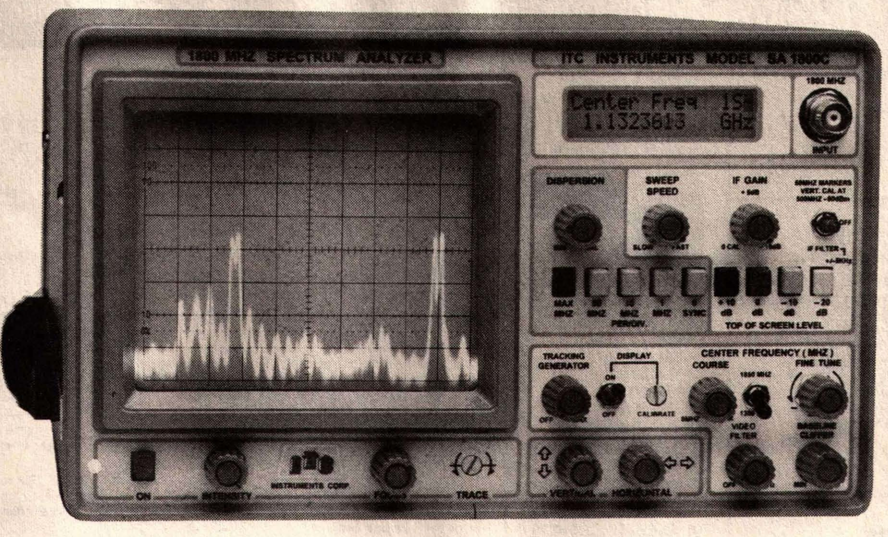
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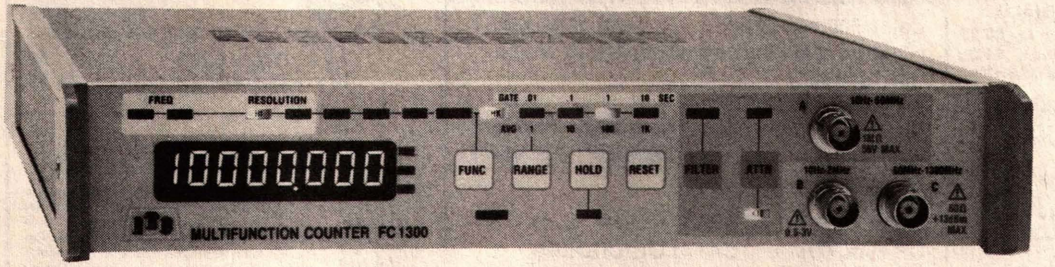
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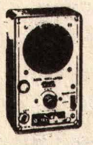

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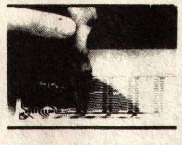

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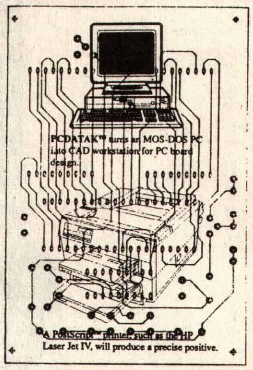

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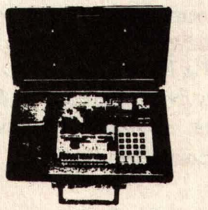

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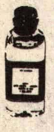

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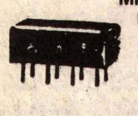

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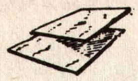

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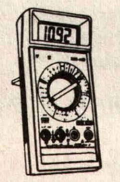

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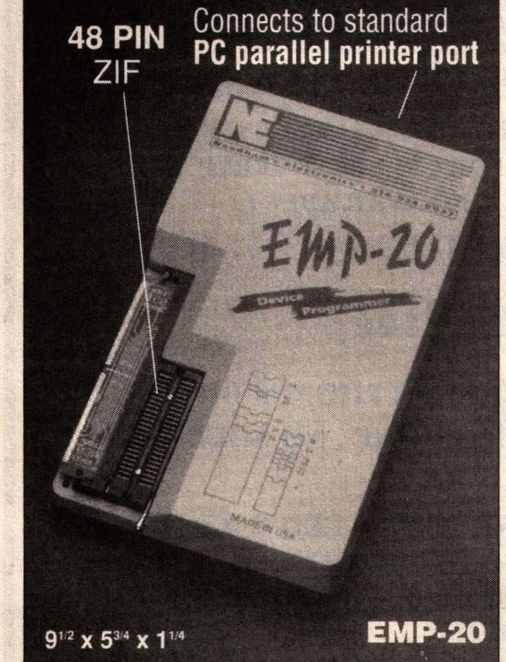

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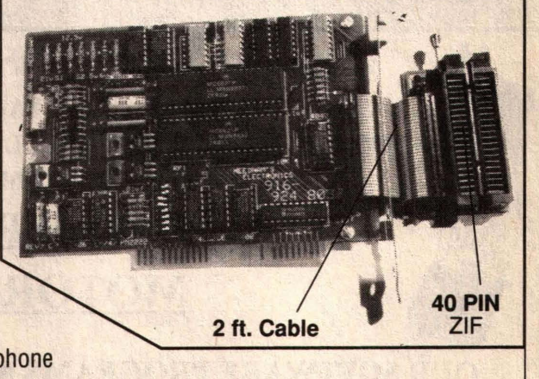

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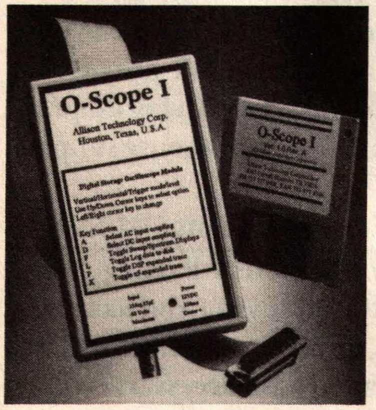

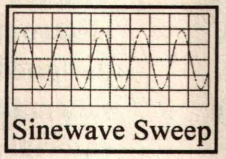
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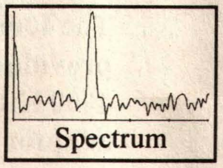
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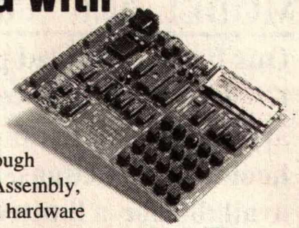

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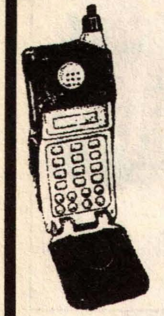

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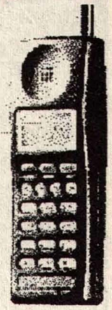

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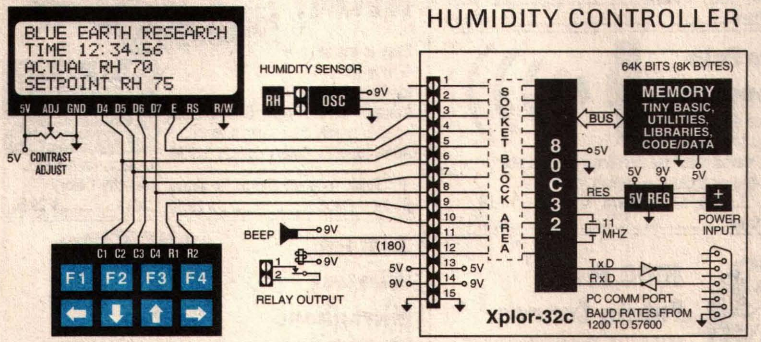
$89.95

- **80C32 CPU with 12 digital I/O lines**
- **64K bit EEPROM for program/data storage**
- **I/O socket block for transistors, resistors, etc.**
- **Screw terminal block and project case.**

Also available with 11 channel 10-bit A/D converter – Xplor-32ca

Built-in BASIC Language, Powerful Utilities, and Library Functions Make Programming Easy

The example below shows how easy it is to wire-up and program the Xplor-32c for a simple on/off controller application. The built-in software gives you the power to write programs like this in just minutes. Your program is stored in nonvolatile memory and will automatically execute when power is applied.


HUMIDITY CONTROLLER
BLUE EARTH RESEARCH
TIME 12:34:56
ACTUAL RH 70
SETPOINT RH 75
5V ADJ GND D4 D5 D6 D7 E RS R/W
5V CONTRAST ADJUST
C1 C2 C3 C4 R1 R2
F1 F2 F3 F4
HUMIDITY SENSOR
RH
OSC
9V
BEEP
9V
(180)
1 2
9V
RELAY OUTPUT
5V
9V
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
SOCKET BLOCK AREA
80C32
64K BITS (8K BYTES)
MEMORY
TINY BASIC, UTILITIES, LIBRARIES, CODE/DATA
BUS
5V
RES
5V REG
5V 9V 5V
POWER INPUT
11 MHZ
TxD
RxD
PC COMM PORT
BAUD RATES FROM 1200 TO 57600
Xplor-32c

ALL YOU NEED IS A PC and a Terminal Program (Or Xplor Starter Package)

No Other Programming Equipment Required!

```
10   CALL 8132                          (LIBRARY FUNC: Initialize LCD)
20   ONTIME 200                         (Initialize 1 second interrupt)
30   PRINT "BLUE EARTH RESEARCH" ;      (Display sign-on message)

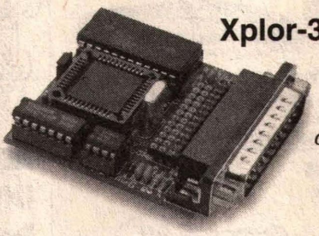
40   PRINT  " \\ ACTUAL RH " ; FREQ  0 ; (Display actual sensor frequency)
50   PRINT " \\\ SETPOINT RH " ; S ;    (Display desired setpoint value)

60   CALL 8140                          (LIBRARY FUNC: Get keypad input)
70   IF DBY 27=6 THEN S=S - 1           (Decrement setpoint if down arrow)
80   IF DBY 27=7 THEN S=S + 1           (Increment setpoint if up arrow)

100  IF FREQ 0<S THEN BIT 180=1         (If actual < setpoint then relay on)
110  IF FREQ 0>S THEN BIT 180=0         (If actual > setpoint then relay off)
120  GOTO 40                            (Loop back to repeat program)

200  PRINT " \TIME " ; DBY 51 ; " : " ;  (This 1 second interrupt routine)
210  PRINT DBY 50; " : " ; DBY 49 ; : IRET ( refreshes LCD with current time. )
```

Xplor PDCs – MORE CHOICES FOR GREATER FLEXIBILITY



Xplor-32 $59.95

Same features as the 32c less case and terminal block. Board is only 2.15" x 2.2".

Xplor-32a $79.95

with 11 channel 10-bit A/D converter.

Xplor-32d $79.95

with 24 extra digital I/O lines.

Complete Packages from $99.95

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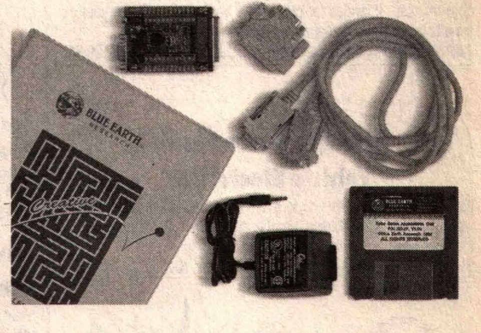

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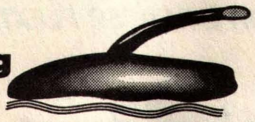

Remember War of the World? Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or great science project.

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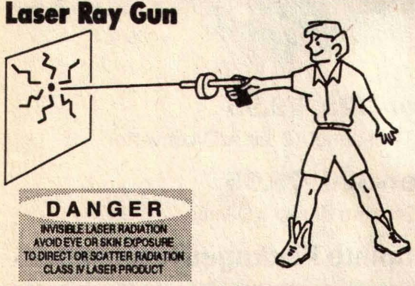
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TO DIRECT OR SCATTER RADIATION
CLASS IV LASER PRODUCT

Advanced project produces a burst of light energy capable of burning holes in most materials. Hand-held device uses rechargeable batteries. 500 joules of flash energy excite either a neodynium glass, yag or other suitable 3" laser rod. This is a dangerous CLASS IV project (individual parts/assemblies available). **LAGUN1 Plans** **$20.00**

LAGUN1K Kit / Plans ...... **Price on Request**

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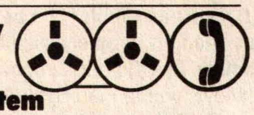

READY TO USE! Automatically controls and records on our X-4 extended play recorder, taping both sides of a telephone conversation. Intended for order entry verification. Check your local laws as some states may require an alerting beeper.

TAP20X Ready to Use System **$129.50**

Shocker Force Field/ Vehicle Electrifier

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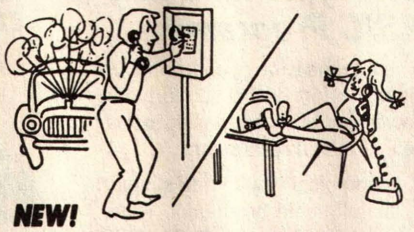

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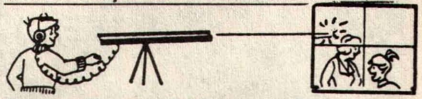

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3mw Visible Red Pocket Laser

Utilizes our touch power control!

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LM337K	3.59
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LM338K	4.95
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LM358	.59
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#EN-290-010 $10 50 (1-3) $9 80 (4-UP)

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LEATHERMAN

The Leatherman tool is an extremely versatile and durable compact toolchest you can hold in your hand ... contains 12 useful tools in one! Needlenose pliers, regular pliers, awl, Phillips screwdriver, three slotted screwdrivers, can and bottle opener, wire cutters, file, knife, and 8 inch ruler. Made of only the highest quality 100% stainless steel. Includes sturdy leather sheath. 25 year manufacturer warranty. Net weight: 5 oz.

#EN-360-990 .... $39 95 (1-3) $37 50 (4-UP)

Fluke Model 73

The Model 73 features a high resolution 3200 count display and 31 segment bar graph. Reads DC to 1000V and AC to 750V, with 0.4% basic DC accuracy. Fused 10A current range, DC and AC current with 1.5% basic DC accuracy. Resistance ranges: 320 ohm to 32M ohms. Includes 9V battery, test leads, and manual. Net weight: 1 lb. FLUKE.

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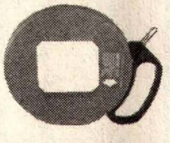
Fish Tape Reel



50 ft. fish tape on a tool box size reel. Perfect for snaking wires under carpet or through walls. Use for stereo speaker wires, phone lines or cable TV coax. 7" diameter fits easily into most tool boxes.

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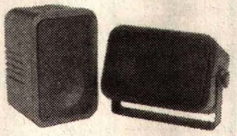
The ideal soldering iron for field repairs where no AC power is present. Operates for up to 100 minutes of continuous soldering per refill. Uses standard butane (not included) available at most stores. Tip temperature is adjustable up to 1067° F. Iron also comes with a torch attachment which easily screws on in place of the soldering tip. As a torch, one refill will provide up to 1 hour of continuous flame. Temperature is adjustable up to 2372° F. A protective cap with a built-in striker and 2.4mm tip are included. Limited one year warranty.

ISOTIP
cordless soldering iron

#EN-370-235 .... $26 95 EACH

Mini Weatherproof Speaker System



These mini weatherproof speaker cabinets are made from high impact polypropylene which is completely weather sealed making these perfect for indoor or outdoor use. These great sounding mini speakers feature a 5" polypropylene cone woofer and a mylar dome tweeter. Ideal for use as extension speakers or for surround sound. Small size blends easily into any decor. Frequency response: 130-20,000 Hz. 8 ohm impedance: 30 watts RMS, 60 watts maximum power handling capability. Mounting brackets included. Dimensions: 8" (H) x 5-1/2" (W) x 4-1/2" (D). Net weight: 10 lbs.

#EN-310-020 (Black)

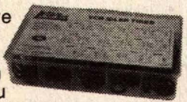
#EN-310-025 (White) .... $79 95 PAIR

Fluorescent Magnifier Bench Lamp

Multi-position, 45" fully adjustable swing arm with metal C-clamp. Features a bright 22 watt fluorescent tube, 4-5/8" diopter magnifying (3x magnification factor), and wire clip for easy removal/installation of fluorescent tube. UL listed. 117 VAC. Black color. Net weight: 7-1/2 lbs.

#EN-350-020 .... $63 80 EACH

Idler Tire Kit



Make VCR tire repairs quickly by having the tire you need in stock when you need it. This comprehensive kit contains 180 of the most commonly used tires in an easy-to-use case and a cross reference with 80 manufacturer assembly numbers crossing to over 200 VCR model numbers. A $400.00 retail value. Net weight: 1-1/2 lbs.

#EN-400-900 .... $39 95 KIT

12V, 15 Ah Battery

GS
PORTALAC

Save big on this rechargeable lead acid battery. Has many uses: computer back-up upgrade, alarm back-up battery, garden tractor starter battery, and more. Sealed in a high impact polystyrene case. Bolt and nut type terminals. Dark blue color. Dimensions: 7"W x 6-1/2"H x 2-15/16"D. Net weight: 14 lbs. Limited availability.

Compare to

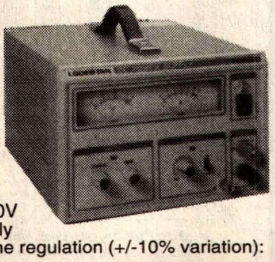
#EN-149-100 .... $60 00 .... $29 95 (1-3) $24 95 (4-UP)

2MHz Function Generator

Versatile digital function generator provides sine, square, triangle, pulse and ramp waveforms from 0.2 Hz to 2 MHz in 7 ranges. 4 digit LED display with Hz, KHz, and gate for internal frequency only. TTL and CMOS outputs. Gate time: 0.1 sec, 1 sec., and 10 sec. Accuracy: 30 ppm +/- one count. Output: 5mV p-p to 20V p-p (open circuit). DC offset: +10V to -10V with CAL, SW. Duty cycle: 20% to 80% with CAL, SW. Voltage controlled frequency (VCF) input of 0-10V. Includes test lead, AC power cord, and manual. Dimensions: 4-1/4"H x 8-1/2"W x 11"D. Net weight: 5 lbs.

#EN-390-640 .... $229 95

Variable Output Bench Top Power Supplies



Heavy duty power supplies suitable for lab work. Provides excellent regulation and low ripple characteristics. Features variable voltage control, variable current control with Hi-Lo ranges, isolated output, and allows for serial or parallel connection of multiple units. Fully adjustable current limiting protects circuit under test and power supply. Protected from reverse polarity, overvoltage, and short circuit.

Specifications:

Constant Voltage Mode: ◆Voltage control: 0V to rated voltage, coarse and fine, continuously variable. ◆Load regulation: 0.01% +3mV ◆Line regulation (+/-10% variation): 0.01 +3mV ◆Noise and ripple: <1mV RMS.

Constant Current Mode: ◆Current control: 5% to 100% rated current, Hi-Lo ranges, continuously variable. ◆Load regulation: 0.2% +3mA ◆Line regulation: 0.2% +3mA ◆Noise and ripple: <3mA RMS.

Part #	Voltage	Current	Dimensions	Weight	Price
EN-120-620	0-16V	10 amp	8.5" x 12" x 6.25	25 lbs	$289.00
EN-120-600	0-30V	3 amp	8.5" x 10.25" x 6.25"	11 lbs.	159.00
EN-120-605	0-30V	5 amp	8.5" x 10.25" x 6.25"	15 lbs.	219.95
EN-120-625	0-30V	10 amp	8.5" x 12" x 6.25"	26 lbs.	399.95
EN-120-610	0-60V	3 amp	8.5" x 12" x 6.25"	18 lbs.	289.95
EN-120-615	0-60V	5 amp	8.5" x 12" x 6.25"	25 lbs.	399.95

Technician's Turntable

Turntable to speed repair of VCRs, TVs and more. Allows technician to easily turn unit for convenient repair. Dimensions: 20"W x 15"D x 1-1/8"H. Black pebbled surface. Includes 4 anti-skid adhesive feet. Net weight: 9 lbs.

#EN-360-427 .... $28 50 EACH

M.E.C.P. Study Guide

This book is the most comprehensive study guide available for the Mobile Electronics Certification Program. Endorsed by the Mobile Electronics Association, the M.E.C.P. Study Guide covers electronic theory and principles, car audio, security and cellular installation. This program is designed to test installers at various levels of ability, allowing them to earn Installer, First Class, Specialist, and Master Installer certificates. It also serves as the perfect reference manual for anyone interested in mobile electronics. Copyright: 1993. Net weight: 1-1/2 lbs.

#EN-500-230 .... $29 95 EACH

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TUBING KIT

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#EN-082-900 .... $\$29^{95}$

Tripp Lite Audio Video System Power Protection

TRIPP LITE
"THE POWER PEOPLE"

Now you can get the proven Tripp Lite power protection right in your audio rack! The IBR-12 rackmount Isobar has all the advanced features you expect from an Isobar, in a convenient 1-rack space unit. 12 outlets provide ample power for all your audio/visual gear and two isolated filter banks provide you with extended noise filtering for your most sensitive equipment. Features the $10,000 Ultimate Lifetime insurance against surge damage for unit and connected equipment. Dimensions 19" (W) x 1-3/4" (D). Net weight: 4-1/2 lbs.

#EN-125-035 .... $\$125^{00}$

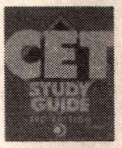
The Wet Look™

The Wet Look™ is a new generation of high gloss polymers formulated especially for speakers. This superior coating provides a protective "coat of armor" for your paper cone speakers. A special U/V inhibitor has been added to reduce the decaying effects of the sun's ultraviolet rays. The Wet Look™ makes paper cones resistant to water, humidity, sun, and salt. Best of all, it's easy to apply and cleans up with soap and water. 1 pint can.

THE WET LOOK

#EN-340-510 (Clear)
#EN-340-512 (Black) .... $\$8^{95}_{\text{EACH}}$

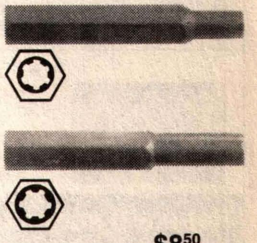
CET Study Guide



322 pages with 179 illustrations. Written by Sam Wilson, the director of CET testing for ISCET. Contains sample tests with answers for both the associate level and journeyman level certified electronics technician (CET). Copyright: 1987; 3rd edition. Net weight: 1 lb.

#EN-500-100 .... $\$17^{95}_{\text{EACH}}$

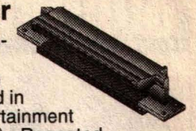
Game Bit Drivers



These special bits are used to remove the star shaped security screws found on many Japanese made video games and other consumer products. The 3.8mm bit works on Nintendo NES, Super NES and Gameboy cartridges. The 4.5mm bit works on NEC Turbo Grafx, Sega cartridges or Nintendo gameboy battery packs. Perfect for cleaning contacts, replacing batteries and installing rental security tabs.

#EN-360-215 (3.8mm)
#EN-360-216 (4.5mm) .... $\$9^{50}_{(1-9)}$ .... $\$8^{50}_{(10-UP)}$

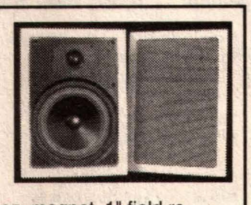
72 Pin Game Cartridge Connector



Quality replacement for the game cartridge connector used in Nintendo Entertainment Systems (NES). Repeated loading and removal of game cartridges damages the connector contacts and produces symptoms such as a flashing blank screen or distorted picture. Revitalize your unit by replacing the game connector. It's simple; there is no soldering required and only a phillips head screwdriver is needed to complete installation in minutes! Our replacement connector has gold plated game contacts for long life, superior conductivity, and resistance to oxidation. One year warranty.

#EN-091-900 $\$8^{95}_{(1-9)}$ $\$7^{95}_{(10-UP)}$

6-1/2" Two-Way System



The basis of all architectural audio systems. This is our most popular in-wall. The perfect system for main and/or surround speakers. Easily installed in any 2 x 4 or larger wall. Retrofit design allows installation in new or existing walls in minutes. All of our in-walls feature high quality crossovers and premium drivers that can outperform the name brands. **Specifications**: 6-1/2" poly woofer with a 10 oz. magnet, 1" field replaceable soft dome tweeter. Integral 2-way crossover with pushbutton wire terminal. 8 ohm impedance. Frequency response: 40-20,000 Hz. 40 watts RMS/80 watts max power handling capability. Sensitivity: 90 dB 1W/1m. Dimensions: 8-1/2" (W) x 12" (L) x 3-1/2" (D). Net weight: 9 lbs. per pair.

#EN-300-036 ... $\$249^{95}_{\text{(SUG. LIST)}}$ .... $\$124^{90}_{\text{(1-3 PRS)}}$ .. $\$112^{95}_{\text{(4 PRS-UP)}}$

Digital Caliper

High precision caliper measures in either inches or millimeters from 0 to 6 inches or 0 to 150 millimeters. Five digit LCD display. Serial output for computer interface and printing. Made of stainless steel with precision ground lapped measuring surface and epoxy embedded linear scale to ensure precise measurement. Includes deluxe hard case, battery, and manual. Weight: 1 lb.

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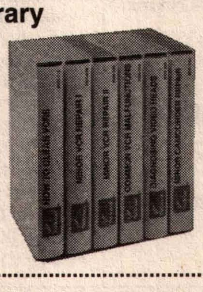
Video School videos make it easy for anyone to comprehend the complex operations of VCRs, camcorders, and more. From How to Clean VCRs for the video rental store, to Minor Camcorder Repair for the advanced service shop. There is something for everyone! These tapes also make great new employee orientation videos.

Electronic Video Library

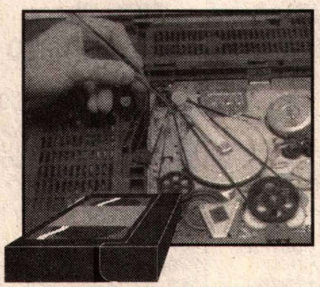


BUY THE SET AND SAVE!

Save over $30.00 by purchasing this complete library of six Video School instructional videos. You'll receive VCR 1- How To Clean VCRs, VCR 2-Minor VCR Repair I, VCR 3-Minor VCR Repair II, VCR 4-Common VCR Malfunctions, VCR 5-Diagnosing Video Heads, and Cam 1 - Minor Camcorder Repair. Net weight: 5 lbs.

#EN-505-550 .... $\$195^{00}_{\text{EACH}}$

Part #	Description	Price
EN-505-010	VCR 1, How To Clean VCRs	$29.95
EN-505-020	VCR 2, Minor VCR Repair I	39.95
EN-505-025	VCR 3, Minor VCR Repair II	39.95
EN-505-050	VCR 4, Common VCR Malfunctions	39.95
EN-505-035	VCR 5, Diagnosing Video Heads	39.95
EN-505-030	VCR Test Patterns Alignment Tape	24.95
EN-505-040	Cam 1, Minor Camcorder Repair	39.95
EN-505-085	Microwave Oven Repair	44.95
EN-505-080	Nintendo Repair and Maintenance	34.95
EN-505-090	IBM Compatible Computer Assembly	34.95
EN-505-095	Hi-Fi Alignment Test Tape	34.95
EN-505-097	Economy Test Tape	19.95



Skew Driver Pro

This unique tool features a gear driven offset bit driver to be used in tight spots or where conventional screwdrivers just won't fit. Includes 1/4" and 3/16" slotted bits, T15 Torx® bit, and 2 phillips bits that are contained in the handle compartment. Can also be used with a 1/4" electric drill. Made in the U.S.A. Net weight: 1/2 lb.

#EN-360-178 $\$39^{90}_{(1-5)}$ $\$34^{50}_{(6-UP)}$

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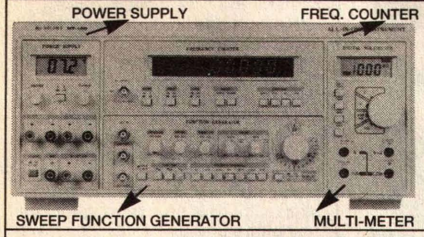


MT-100

Reg. $599.

$399.00

Four Instruments in One Instrument

1 Function Generator
- Sine, Square, Triangle, Pulse, Skewed Sine, Ramp, TTL
- 0.2 Hz ~ 2MHz

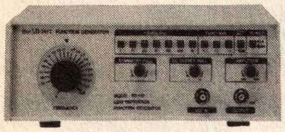
2 Frequency Counter
- 8 Digit LED
- 1 Hz ~ 100MHz
- ± (1 Hz + 1 dgt. + Time Base Error)

3 Power Supply
- 3-1/2 Digit LCD
- Triple output: #1. 0~50V, 0.5A MAX #2, 15V, 1A #3. 5V, 2A

4 Digital Multimeter
- 3-1/2 Digit LCD
- DCV, ACV, Ω, DCA, ACA
- ± (0.5% + 2 dgts)

FG-140 2MHz Function Generator

Reg. $249. **$149.00**

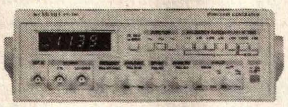


- 0.2 Hz ~ 2.0 MHz, 7 Decades
- Sine, Square, Triangle, Pulse, Ramp, Skewed Sine
- VCF, Symmetry
- Variable DC Offset Control

2MHz Sweep Function Gen. w/Freq. Counter

FG-150

Reg. $399. **$229.00**

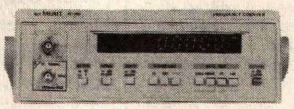


- 4 Digit LED Display
- Sine, Square, Triangle, TTL, Pulse, Ramp, Skewed Sine
- Linear/Logarithmic Sweep
- 10 MHz Freq. Counter

1.0GHz Frequency Counter, High Resolution

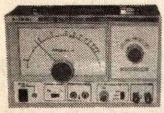
FC-200

Reg. $399. **$209.00**



- 1.0 Hz ~ 1.0 GHz
- 8 Digit LED Display
- Auto & Manual Range
- 4 Selectable Gate Times
- 1MΩ & 50Ω Input Impedance

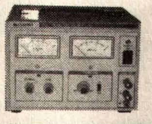
AG-350 Audio Generator



Reg. $199. **$119.00**

- 10 Hz ~ 1 MHz, 5 Ranges
- Sine Output: 10Hz - 1MHz
- Square Output: 10Hz - 100KHz

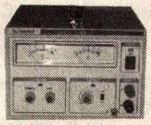
PS-500 DC Power Supply



Reg. $249. **$159.00**

- 0 - 30 VDC
- 0.1 ~ 3A
- Short & Overload Protection

PS-540 DC Power Supply

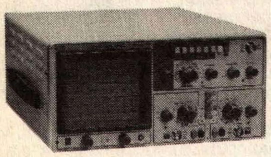


Reg. $399. **$289.00**

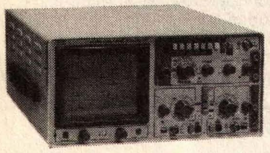
- 0 - 16 VDC
- 0.1 ~ 10A
- Short & Overload Protection

Deluxe O'scopes w/Phillips CRT. 2 yr. Parts/Labor Warranty

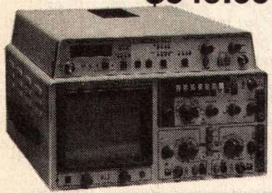
OS-3304 *Reg. $499.* **$339.00**



OS-3324 *Reg. $599.* **$399.00**



OS-3344 *Reg. $899.* **$649.00**



OS-3304 25MHz, Dual Trace

1 • DC to 25 MHz. Dual Channel
- 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
- Uncalibration LED.
- High Sensitivity 1 mV/div to 20V/div X-Y modes, Z Axis (intensity modulation)
- Rise time 14n Sec. or less.
- Full TV Trigger for TV-V & TV-H
- Acceleration Potential 2kV
- 60MHz (X1.X10) Probe Kit: 2 sets
- Power: 115/230V AC

OS-3324, 3 Function

1 • OS-3304

2 • Dual Component Tester/Comparator

3 • Triple DC Power Supply 5VDC, +12 VDC, -12VDC

OS-3344, 5 Function

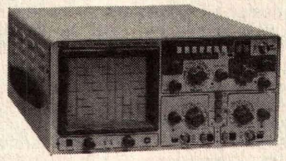
1 + 2 + 3 • OS-3324

4 • Frequency Counter 100MHz, 7 Digit LED Display

5 • Function Generator 0.02 Hz to 2.0 MHz

OS-3315 40MHz, Dual Trace Sweep Delayed

Reg. $799. **$549.00**



- DC to 40 MHz. Dual Channel
- Delayed Sweep 100nS to I.O.S. 7 decade
- 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
- Uncalibration LED.
- High Sensitivity 1 mV/div to 20V/div X-Y modes, Z Axis (intensity modulation)
- Rise time 8.5nS or less.
- Full TV Trigger for TV-V & TV-H
- Acceleration Potential 12kV
- Variable Hold Off
- 16ns ~ 1.0s Time Base
- 60MHz (X1.X10) Probe Kit: 2 sets
- Power: 115/230V AC

Capacitance Meter

Reg. $79. **$49.00**

CM210

- 3 1/2 Digit LCD
- 0.1p - 20.000μF 9 Ranges
- 0.5% basic Accu.
- Zero Adjust Knob

Digital Clamp-On

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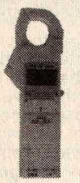
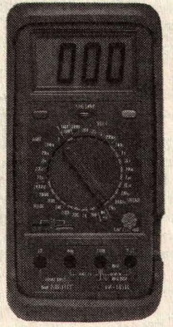
DA400



- 400 Amp AC
- 3 1/2 Digit
- Auto
- Data Hold
- Continuity
- Over Range Mark
- Case Included

Multimeter+ Extended Range Capacitance

Reg. $149. **$89.00**



DM5050C
- 9 Function / 42 Range
- Basic DCV Accu.: ± 0.25%
- Multimeter
  - Volt: AC/DC
  - Amp: AC/DC **2A**
  - Ohm: Up to **2000MΩ**
  - Diode,
  - Continuity Beeper
- Capacitance (9 Range) **0.1**pF - **20,000** μF Zero Adj. Knob
- Trig Lamp
- Double Insulated Jack
- Alligator Clip Test Leads
- Deluxe Holster w/Strap

Wide Range Multimeter w/Logic

Reg. $149. **$89.00**

DM5100
- 11 Function / 45 Range
- Basic DCV Accu.: ± 0.25%
- 3 1/2 Digit Manual
- Auto Power Off
- Data Hold & Peak Hold
- Amp: Up to **20A** AC/DC
- Ohm: Up to **200** MΩ
- Freq: Up to **20MHz**
- Capacitance: **1p** - **200**μF
- Logic: TTL
- TR hFE, Diode
- Continuity Beeper
- Double Insulated Jack
- Alligator Clip Test Leads
- Deluxe Holster w/Strap

Oscilloscope Probe Kit

Switch Selectable X1 / X10

HP-9060, 60MHz *Reg. $29.* **$17.00**

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HP-9250, 250MHz *Reg. $59.* **$32.00**

Pen-Type DMM w/Logic

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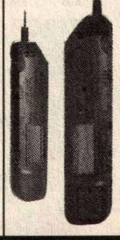
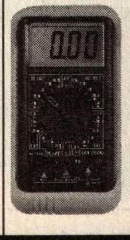


DM150
- 3 1/2 Digit
- Dual Display
- Auto & Manual
- DCV, ACV, ACA, DCA, Ω
- Logic CMOS/TTL
- Data Hold
- Diode
- Continuity

DMM w/Holster

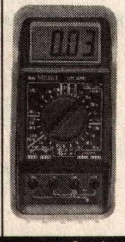
Reg. $59. **$39.00**



DM2500
- 3 1/2 Digit
- 1.5" Big LCD
- 10A AC/DC AC/DC V, Ω
- Signal Injector
- Diode
- Continuity
- Holster

Multifunction DMM

Reg. $89. **$59.00**



DM3050
- 3 1/2 Digit
- 1.5" Big LCD
- Heavy Duty, 20A AC/DC
- Capacitance
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- Diode
- Continuity
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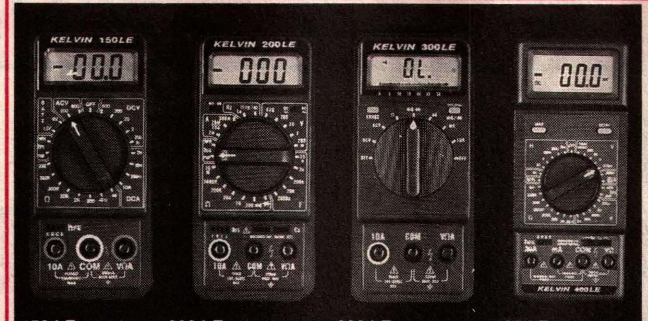
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KELVIN 300LE
KELVIN 400LE

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Standard Features • AC & DC VOLTAGES • DC CURRENT • RESISTANCE • CONTINUITY TESTER - Buzzer • DIODE TEST • 10M ohm INPUT IMPEDANCE • ACCURACY +/- 0.5% RDG

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Designed to meet IEC-348 & UL-1244 safety specifications.

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# 990087 $19.95

- AC & DC VOLTAGES
- DC CURRENT
- RESISTANCE
- 3 1/2 Digit LCD
- CONTINUITY TEST
- -Buzzer
- LOW BATTERY INDICATOR
- DIODE TEST
- BATTERY TEST

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# 990126 $59.95

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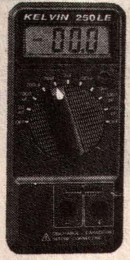
- Zero Adjust
- Safety Test Leads
- Test Socket for Plug-in Components


KELVIN 250LE

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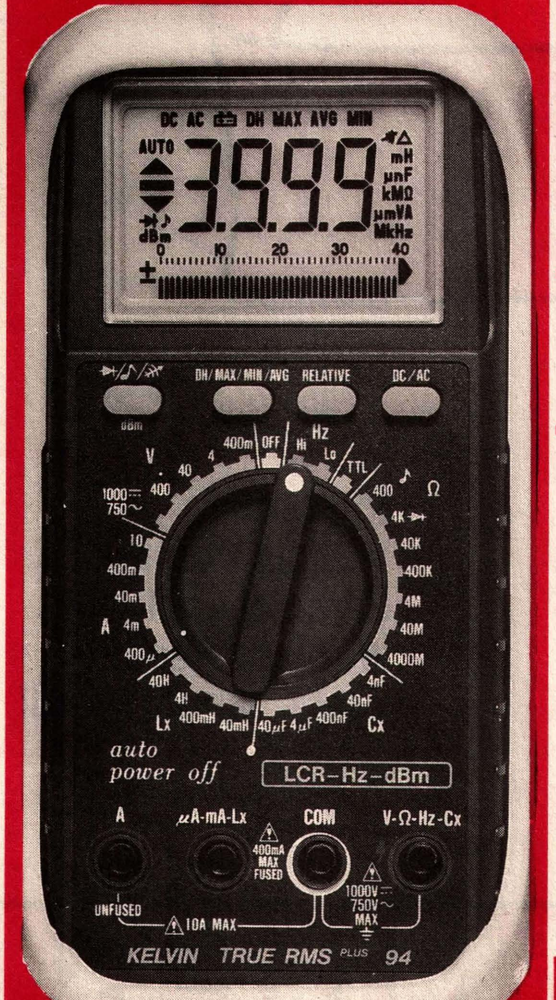
For Models 100 Basic, 150LE, 200LE, 300LE .... $4.95 (#990088)

Case For Model 400LE .... $9.95 (#990116)

2 Year Warranty (Parts & Labor)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dBm
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Popular Electronics (Reviewed - May 1993)

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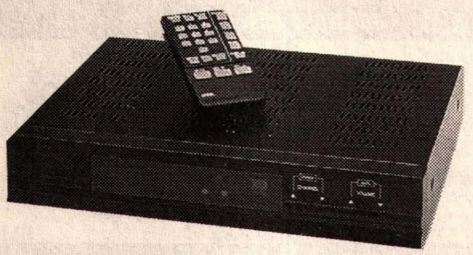
Tocom	**5503**	**$239**
Pioneer	**6300**	**$319**
Pioneer	**6150**	**$299**



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NV56 COMBO

Pioneer compatible. Replaces all models 5000-6310.

NV 57 COMBO

Jerrold/GI compatible. Replaces all models except baseband.

NV 58 COMBO

Scientific Atlanta compatible. Replaces all models except baseband.

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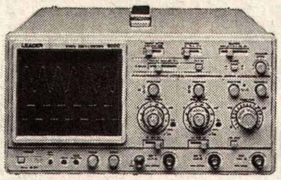

Model			Reg. $
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8060	60 MHz	3-Ch. Dlyd. Swp., TV Sync	$1,345.00
8100	100 MHz	2-Ch. Dlyd. Swp., TV Sync	$1,595.00
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LDC-822	80 MHz,	7 digit, 5 ppm	$395.00
LDC-823S	250 MHz ,	8 digit, 1 ppm	$595.00
FUNCTION & RF SIGNAL GENERATORS			
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LFG-1310	10 MHz	Sweep/Function Generator	$1,095.00
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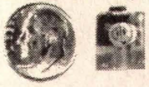
- Tunes 88-108 MHz.
- Powerful 2 stage audio amplifier.
- Sensitive, picks up sounds at the level of a whisper.
- Up to 1 mile range.

SUPER-MINIATURE FM TRANSMITTER

Worlds smallest FM transmitter. Use with any FM broadcast receiver. Easy to assemble, all chip (SMT) parts are pre-assembled to the circuit board.

XST500 (E-Z) Kit $44.95



- Smallest Phone transmitter anywhere!
- Tunes 88-108 MHz.
- No batteries required, powered by phone line.
- Up to 1/4 mile range.
- Attach to phone line anywhere in house, even inside phone.

SUPER-MINIATURE PHONE TRANSMITTER

Worlds smallest FM phone transmitter. Use with any FM broadcast receiver. Easy to assemble, all chip components are pre-assembled to the circuit board.

XSP250 (E-Z) Kit $34.95

- Uses sensitive microwave transistor amplifier.
- Covers 1 to 2,000 MHz.
- Compact hand held unit.
- Includes miniature loud speaker for audio indication of detected signals.

SUPER SENSITIVE BUG DETECTOR

When the XBD200 intercepts a signal in the 1 to 2,000 MHz range, it emits a growl that increases to a high pitched squeal as the signal strength increases.

XBD200 (C) Kit $49.95

- Transmit high quality stereo to any FM stereo receiver.
- Built-in output level monitor for quick and easy tuning.
- Ideal for use with personal CD player.

FM STEREO TRANSMITTER

Transmit full-bodied Hi Fi stereo to any FM stereo receiver. Separate left and right inputs and gain controls. Includes an output booster stage for greater range.

XFS-CASE KIT $13.95

XFS108 (C) KIT $41.95

- Dial your phone from anywhere and listen to the sounds inside your home.
- Two digit Touch Tone code for secure operation.

TELEPHONE SNOOP

The latest in home or office security. Call home from anywhere, enter a two digit security code, and hear the sounds in your home . Automatically turns on without ringing the phone, verifies code, then activates for one and a half minutes.

XPS-CASE KIT $13.95

XPS1000 (C) KIT $49.95

- Transmits a continuous beeping tone.
- Adjustable from 88 to 108 MHz.
- Up to 1 mile range.
- Works with any FM broadcast receiver.

TRACKING TRANSMITTER

Only 0.7 by 2.4 inches, the XTR100 operates at voltages of 3 to 18 Volts and is ideal for use in locating lost model rockets, bicycles, automobiles, games of hide and seek, and contests.

XTR100 (C) Kit $33.95

- Works with any FM broadcast receiver.
- Turns off when phone is not in use to extend battery life.
- Adjustable from 88 to 108 MHz.
- Up to 1 mile range.

LONG RANGE PHONE TRANSMITTER

Similar to our very popular XSP250, the XTT100 is battery powered for greater range. It plugs into any phone jack and transmits both sides of conversations on that line.

XTT100 (C) Kit $32.95

- Use with any FM broadcast receiver.
- Hear every sound in an entire house!
- Up to 1 mile range
- Powerful 2 stage audio amplifier.

MINIATURE FM TRANSMITTER

The XFM100 has a super sensitive microphone and is capable of picking up sounds at the level of a whisper and transmitting them to any FM broadcast receiver.

XFM100 (C) Kit $32.95

- Digital voice changing: male to female, female to male, adult to child, child to adult.
- Anonymity on any call.
- Button for normal operation.
- 16 levels of voice masking.

VOICE CHANGING TELEPHONE

STOP THOSE ANNOYING TELEPHONE CALLS! Sound older and tougher when you want to. Not a kit. Fully assembled. Single phone operation only.

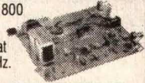
TRANSITION 2000 .... $89.95

- Digital voice changing: male to female, female to male, adult to child, child to adult.
- Use with any modular phone.
- 16 levels of voice masking.
- Connects between handset and phone.

VOICE CHANGING ACCESSORY

STOP THOSE ANNOYING TELEPHONE CALLS! Sound older and tougher when you want to. Not a kit. Fully assembled. Use with single or multi-line phones.

TRANSITION 2001 .... $59.95



- Uninterrupted coverage of 800 to 950 MHz.
- Works with any scanner that can receive 400 to 550 MHz.

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If your scanner can receive 400-550 MHz, just add the XLC900 for uninterrupted 800-950 MHz coverage. It converts all 800-950 MHz signals down to 400-550 MHz so your scanner can receive them! Add our custom case kit for that "Professional" look.

XLC-CASE KIT $13.95

XLC900 (C) KIT $49.95

- Works with most any scanner.
- 10 TO 1000 MHz.
- 10 dB typical gain.
- 3 dB typical noise figure.

10 -1000 MHz AMPLIFIER

Designed to help scanners with poor sensitivity pull in those weak signals. Includes OFF/BYPASS switch for returning to normal operation and front panel gain control. Add our custom case kit for that "Professional" look.

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FIBRE OPTIC TUBES

These US made tubes are "pulls" from equipment, in excellent condition. Have 25/40mm diameter, fiber-optically coupled input and output windows. The 25mm tube has an overall diameter of 57mm and is 60mm long, the 40mm tube has an overall diameter of 80mm and is 92mm long. The gain of these is such that they would produce a good image in approximately 1/2 moon illumination, when used with suitable "fast" lens, but they can also be IR assisted to see in total darkness. Our HIGH POWER LED IR ILLUMINATOR kit, and the IR filter are both suitable for use with these tubes. The superior resolution of these tubes would make them suitable for low light video preamplifiers, wild life observation, and astronomical use. Each of the tubes is supplied with an 9V-EHT power supply kit. INCREDIBLE PRICES:

$85 For the 25mm intensifier tube and supply kit.

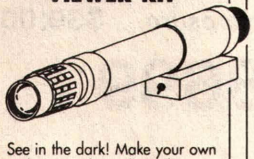
$130 For the 40mm intensifier tube and supply kit.

We also have a good supply of the same tubes that may have a small blemish which is not in the central viewing area.

$50 For a blemished 25mm intensifier tube and supply kit.

$70 For a blemished 40mm intensifier tube and supply kit.

INTENSIFIED NIGHT VIEWER KIT



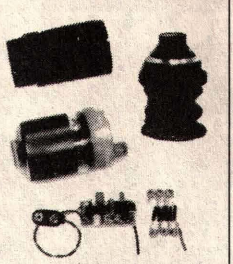
See in the dark! Make your own night scope that will produce good vision in sub-starlight illumination! We supply a three stage fiber optically coupled image intensifier tube, EHT power supply kit, and sufficient plastics to make a monocular scope. The three tubes are supplied already wired and bonded together.

$190 for the 25mm version

$320 for the 40mm version

We can also supply the lens (100mm f2: **$50**) and the eyepiece (**$12**) which would be everything that is necessary to make an incredible viewer!

IR "TANK SET"

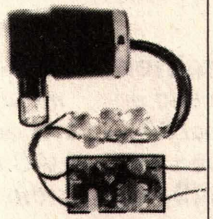


A set of components that can be used to make a very responsive Infra Red night viewer. The matching IR tube, lens and eyepiece sets were removed from working military quality tank viewers. We also supply a very small EHT power supply kit that enables the tube to be operated from a small 9V battery. The tube emloyed is probably the most sensitive IR responsive tube we ever supplied. The resultant viewer requires low level IR illumination. Basic instructions provided.

$105

For the tube, lens, eyepiece and the power supply kit. When ordering specify preference for a wide angle, or a telescopic objective lens.

IMAGE INTENSIFIER TUBE AND SUPPLY

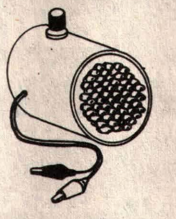


These are the key components needed for making a PASSIVE NIGHT VIEWER. The small prefocussed Russian image intensifier tube only requires a low current EHT power supply to make it operational, which we provide in kit form: Draws 20mA from a small 9V battery. With a suitable low light objective lens (Not provided) the resultant viewer will produce useful pictures in sub-moonlight illumination, and it can also be IR assisted. ON SPECIAL:

$90

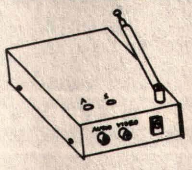
For the Russian image intensifier tube and an EHT power supply Kit. All that is needed to make a complete passive night viewer is a lens, an eyepiece, a 9V battery, a case and a switch.

HIGH POWER LED IR ILLUMINATOR



This kit includes two PCB's, all on-board components plus casing: Switched mode power supply plus 60 high intensity 880nM IR (Invisible) LED's. Variable output power, 6-20VDC input, suitable for illuminating IR responsive CCD cameras, IR night viewers etc. Professional performance at a fraction of the price of the commercial product: COMPLETE KIT PRICE: **$44**

VIDEO TRANSMITTERS



Low power NTSC standard UHF TV transmitters. Have audio and video inputs with adjustable levels, a power switch, and a power input socket: 10-14V DC/10mA operation. Enclosed in a small metal box with an attached telescopic antenna. Range is up to 30ft. with the telescopic antenna supplied, but can be increased to approximately 100ft. by the use of a small directional UHF antenna. INCREDIBLE PRICING:

$18

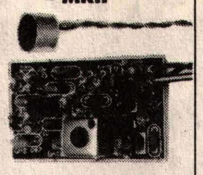
INFRA RED FILTER

A very high quality IR filter and a RUBBER lens cover that would fit over most torches including MAGLITES, and convert them to a good source of IR. The filter material withstands high temperatures and produces an output which would not be visible from a few meters away and in total darkness. Suitable for use with passive and active viewers.

$11

For the filter and the rubber lens cover.

FM TRANSMITTER KIT - MKII



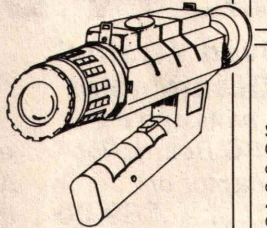
This low cost FM transmitter features pre-emphasis, high audio sensitivity as it can easily pick up normal conversation in a large room. It also has excellent frequency stability. Specifications: Tuning range: 88-108MHz, Supply voltage 6-12V, current consumption @ 9V: 3.5mA, Pre-emphasis: 75µS, Frequency response: 40Hz to greater than 15KHz, S/N ratio: Greater than 60dB, Sensitivity for full deviation: 20mV, Frequency stability with extreme antenna movements: 0.03%, P.C.B. dimensions: 1"x1.7". Construction is easy and no coil winding is necessary. The kit includes a PCB and all the on-board components, an electret microphone, and a 9V battery clip.

$8

SECOND GENERATION TUBES

We should have a regular supply of some new USSR made 18mm 2nd. Gen. Fiber optically coupled image intensifier tubes @ approx. $500 and also some used US-European made tubes @ approx. $330. Some of these may require an export permit.

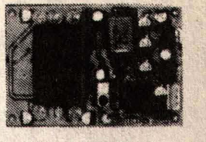
PASSIVE NIGHT VIEWER



This is a completed commercial monocular hand held night viewer, that emplous an image intensifier tube. The viewer is of a USSR military standard, and will produce useful images in very low ambient light. Has adjustable low light objective lens, adjustable eyepiece and is supplied with a carry case. ON SPECIAL:

$220

CCD CAMERA



Monochrome CCD Camera which is totally assempled on a small PCB and includes an Auto Iris lens. 9-12V DC operation. It can work with illumination of as little as 0.1 Lux, and is IR responsive: Can be used in total darkness with Infra Red illumination. A suitable illuminator is our HIGH POWER LED IR ILLUMINATOR kit. Overall dimensions of camera are 24 x 46 x 70mm and it weighs less than 40 grams. Can be connected to any standard monitor or the video input on a Video cassette recorder: EIA (US-NTSC) compatible.

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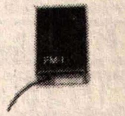
MINIATURE FM TRANSMITTER



Not a kit, but a very small ready made self contained FM transmitter enclosed in a small black metal case. It is powered by a single small 1.5V silver oxide battery, and has an inbuilt electret microphone. SPECIFICATIONS: Tuning range: 88-108MHz, Antenna: Wire antenna – attached, Microphone: Electret condenser, Battery: One 1.5V silver oxide LR44/G13, Battery life: 60 hours, Weight: 15g, Dimensions: 1.3" x 0.9" x 0.4".

$25

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additional transmitter **$11**
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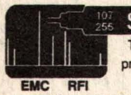

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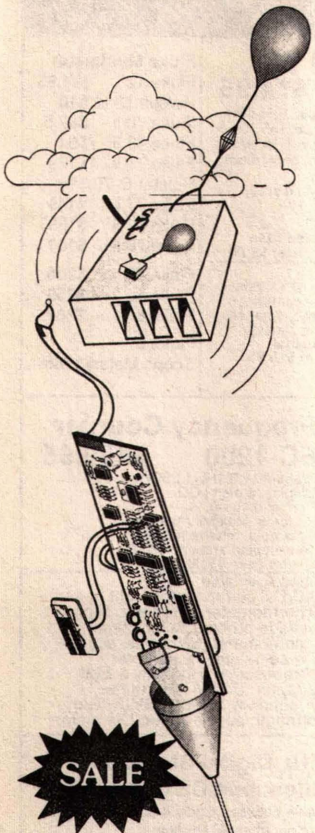

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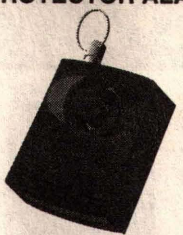
G5058 $6.95

2/$12.00

Very late model Radiosonde made for tracking all types of weather data. These were to be sent aloft attached to a weather balloon (not included). Each is about 10 1/2" long x 3 3/8" thick x 8" wide. Inside of the removable cardboard sleeve is a styrofoam chamber housing a sophisticated 8 IC circuit board which has sensors attached to measure atmospheric pressure, temperature and humidity. As it gathers the information, it transmits the data at about 1.677 gigahertz (GHZ). These are prime, brand new units that were waiting shipment from the manufacturer (Space Data Corporation) to the government when the contract ended. These are complete except for the 24V battery (we connected two 9V batteries in series and the unit worked perfectly from them). Sorry, no schematic available. These cost the government a bundle to have made but we are selling them at a giveaway price. Hurry, get your Radiosonde today!

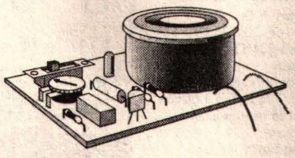
PERSONAL PROTECTOR ALARM



G6152 $12.95

Ear piercing volume of pulsating 130 dB level is emitted from this small device whenever the strap is pulled out. Great for high school or college students, shoppers, joggers, people on night shifts, etc. The sound from this is impossible to ignore-it's absolutely incredible in intensity. Size of alarm only 2 1/8" x 2 3/4" x 13/16". Has removable belt clip. Operates from one 9V battery (not included). In retail blister pack.

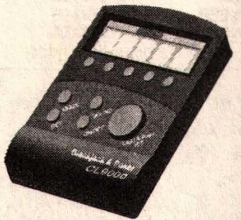
POPULAR ELECTRONIC KITS



We have about 150 different kits. Here's a small sampling.

Insanity Alarm Kit	**C6240**	**$6.20**
Wheel of Fortune Kit	**C3806**	**$13.75**
SMD IR Detector Kit	**C6489**	**$7.20**
Burglar Alarm Kit	**C6280**	**$8.75**
Phasor Sound Kit	**C6406**	**$7.25**
Portable Filtered Black Light Kit	**C6471**	**$23.95**
20W + 20W Car Stereo Amp Kit	**C6442**	**$24.95**

BLACKJACK & POKER GAME

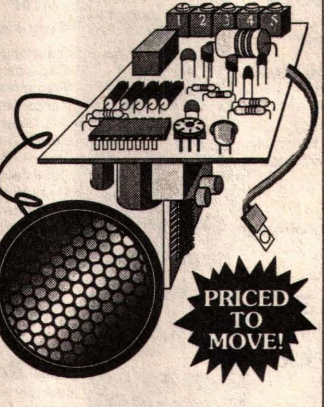


G6135 $19.95

Electronic high-tech game features a large easy to read display and a convenient pocket size. Choose either Poker or Blackjack with the press of a button. Features automatic score keeping and operates from 2 AAA batteries (not included). Blackjack features, split, surrender dealer stand on 17, double down on any points insurance when dealer has 11, variable 1 to 20, betting, etc. Poker features automatic 5 point bet per hand, player can hold or draw 0-5 cards, etc. Each game features music for winning hands. Compact fun game for hours of fun. In retail blister pack.

IF YOU CAN'T FIND WHAT YOU ARE LOOKING FOR, CALL FOR A FREE COPY OF OUR LATEST CATALOG. THIS CATALOG CONTAINS OUR ENTIRE PRODUCT LINE OF OVER 3,000 ITEMS AND IT IS STILL GROWING!

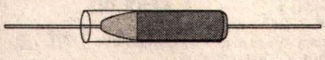
ULTRASONIC PEOPLE DETECTOR


PRICED TO MOVE!

G5809 $14.95

These are very interesting ultrasonic people detectors. They were designed to open doors at stores when a human approached. They have an adjustable range from 4 ft. to 10 ft. with a relay contact closure. Made by a company called Microwave Sensors but these use ultrasonic sensor technology. They are the complete circuit board assembly from their model D14 and feature 12VAC or 24VAC operation (use a transformer or our G950 adapter shown on pg. 71 of our catalog), a conical detection pattern, response time of .2 sec, hold time continuous (as long as you are in its field of view), reset time adjustable 1 to 15 seconds, current draw 60 ma idle, 135 ma activated, fequency 47KHZ, contacts N.O. or N.C. 2 amps. They operate on AC only not DC. Great for opening doors, burglar alarms, robotics, automatic voice greeting activation, etc. These are brand new completely functional board assembly (without case). Simple barrier block connection for AC power and SPDT relay contacts hookup. Size of board: 4" x 2 1/8".

THERMAL FUSE



G5907 3/$1.00

100/$25.00 • 1,000/$220.00

Same type found in copiers, hairdryers, toasters etc. These handle great amounts of current, however, when their temperature rating is exceeded they "blow out" permanently for fail safe operation. This one is made by Microtemp. Rated 167°C (333°F). Brand new-prime.

TRANSISTORS BY THE SCOOP

G5071

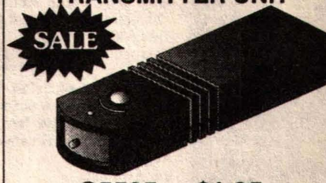
Less than 1¢ each

1 scoop $5.00

10 scoops (about 5,000) **$40.00**

We just purchased close to a 1/2 million prime house numbered transistors made for an OEM. Each is house numbered and has full length leads. They are absolutely first quality - not rejects. We think there are Darlingtons and small signal NPN transistors. We do know that there is at least 4 different house numbers. Most are regular size T092 cases however, there are also a few 1 watt T092 cases. Tremendous value as we are selling them by the scoop. Each scoop holds at least 500 transistors! Sorry we can't separate them, but at this price you can and you'll save a bundle!

SUPER POWER MINIATURE IR TRANSMITTER UNIT

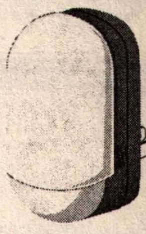


G5535 $1.25

12/$12.00 • 120/$100.00

Make all kinds of IR remote activated projects with this transmitter and an IR receiver module. These were originally designed to activate a burglar alarm system (which we don't have) by remote control. The transmitter features a red activation button, a dip switch inside to change output code, operation from 9V battery (not included), red LED transmit indicator to show when IR energy is being transmitted and a compact 4 1/4" x 1 3/16" x 3/4" black stylish case. Brand new in blister pack with 2 peel and stick "premise protected" stickers. We also supply an info sheet that shows how to convert this transmitter unit into a programmable IR receiver so a pair of these transmitter units could cover both transmit and receive functions.

SONAR LIGHT



Sound activated bright light for dark areas in your house. These react to tapping, knocking, cries of distress, clapping of hands, snapping of fingers, breaking glass, or if the sensitivity control is turned up, just walking on a floor will turn it on. Light remains on for 2 to 5 minutes (selectable) after sound occurs. It is very sophisticated and has an IC circuit. Will not go on except in darkness. Plugs into a standard 120VAC wall outlet and features a bright light in a compact contemparary case. Needs no batteries-complete and ready to go-no more stumbling around in the dark. In retail blister pack.

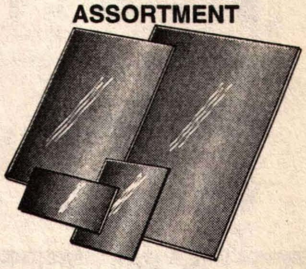
G6134 $7.95

TL084 QUAD OP AMP (SMD)

Prime popular TL084 JFET input tiny SMD case quad op amp.

G6250 79¢

COPPER CLAD ASSORTMENT

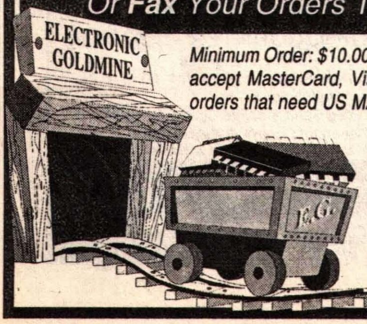


G2679 $5.00

Our best assortment ever. Contains 25 pieces of various size copper clad circuit board blanks. Each is double sided and you will receive thickness types from ultra thin to standard thickness. Minimum size 2" square to a maximum of 6" square. A PC board makers delight.

*For **Phone** Orders Call **(602) 451-7454***

*Or **Fax** Your Orders To **(602) 451-9495***



Minimum Order: $10.00 plus $4.00 Shipping and Handling. We accept MasterCard, Visa and Money orders. Canadians and orders that need US MAIL send minimum $5.00 S&H.

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Scottsdale, AZ 85261

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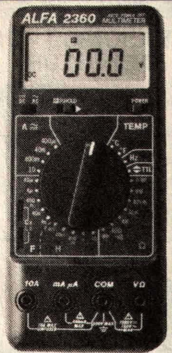
-80.7 to 81.4 dBm with 4Ω –1200Ω
20 reference impedances
True RMS
Frequency counter: 0.01Hz-10MHz
Capacitance: 1pF-50,000µF
Measure AC volt to 20kHz
5000 counts, 0.1% accuracy
Auto/manual range, fast bar graph
Min/Max/Ave/DH/Relative/Zoom
Auto power off
Input warning
Splash proof
Volt, amp, ohm, logic, diode, continuity
Ruggerdized case
Rubber holster included

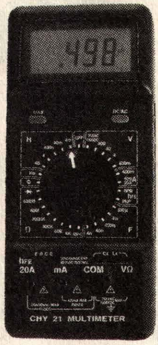


DMM 2360 $119.95

DMM+LCR Meter

Very Versatile DMM

Inductance: 1µH-40H
Capacitance: 1pF-40µF
Frequency: 1Hz - 4MHz
Temperature: -40-302 °F
TTL Logic Test: 20MHz
Diode, Continuity
Volt, Amp, Ohm
3999 count display
Peak Hold
Auto power off
Ruggerdized case.
Rubber Holster $8.00
Temperature probe $7.00



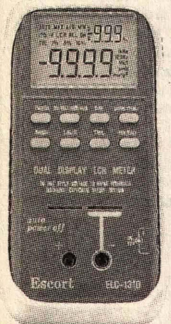
DMM 21 $74.95

Inductance: 1µH-40H
Capacitance: 1pF-200 F
Frequency: 1Hz-1MHz
Volt, amp, ohm, diode, continuity
3999 count display
TTL logic, HFE
Peak hold
Ruggerdized case
Rubber holster $8.00

Full line of DMMs, economy, compact, ruggerdized, solar cell, automotive, heavy duty, industrial, starts from $15.95

Fluke Multimeter

Fluke 12	$84.95
Holster C-10	$10
Fluke 70 II	$67.5
Fluke 73 II	$94
Fluke 75 II	$129
Holster C-70	$16
Fluke 77 II	$149
Fluke 79 II	$169
Fluke 29 II	$169
Fluke 83	$225
Fluke 85	$259
Fluke 87	$287
Fluke 97 Scope Meter	$1785



LCR Meter 131D $229.95

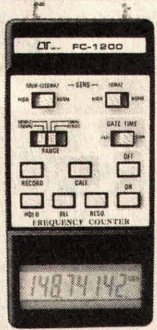
Most Advanced LCR

Dual display:L/Q or C/D
Inductance: 0.1µH-1000H
Capacitance:0.1pF-10,000µF
Impedance:1mΩ-10MΩ
0.7% basic accuracy
Dissipation factor & Q factor
Serial & parallel mode
Relative mode for comparison and to remove parasitics
Statistics, tolerance,
Best for design, incoming testing & production
SMD and chip component test probe $25.00

LCR Meter 814 $189.95

Best Resolution LCR

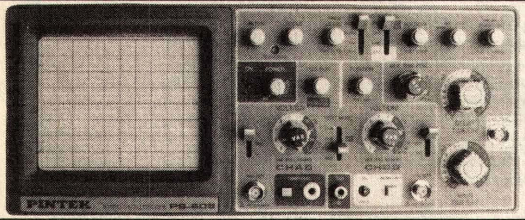
Inductance: 0.1µH-200H
Capacitance: 0.1pF-20,000µF
Resistance: 1mΩ-20MΩ
1% basic accuracy
Dissipation factor indicates leakage in capacitor and Q factor in inductor
Zero adjustment to reduce parasitics from test fixture
Best for high frequency RF and surface mount components.
SMD and chip component test probe $25.00, Deluxe carrying case $5.00



Frequency Counter FC-1200 $129.95

Frequency:0.1Hz-1.25GHz
Display: 8 digit LCD
Period: 0.1µs-0.1s
Records Max/Min/Average
Data hold, relative mode
Telescoping antenna $8.00
Deluxe case $5.00

Also Available:
AC/DC clamp meter, Light meter, Thermometer, pH meter, High voltage probe, Digital caliper, Anemometer, Electronic scale, Force gauge, Tachometer, Stroboscope, Humidity & EMF adapter, Sound level meter, Frequency counter, SWR/field strength/power meter, Dip meter



20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

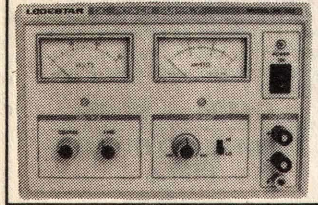
Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z-Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

PS-200 20 MHz DUAL TRACE	$339.95
PS-400 40 MHz DUAL TRACE	$494.95
PS-405 40 MHz DELAY SWEEP	$569.95
PS-605 60 MHz DELAY SWEEP	$769.95

Scope Probe: 60MHz x1, x10 $13, 100MHz x1, x10 $22

20 MHz Digital Storage Oscilloscope DS-203 $729.95

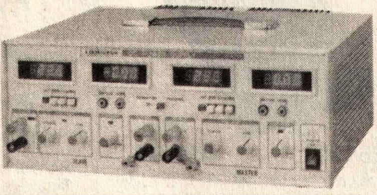
Switchable between digital and analog modes
2 K word per channel storage
Sampling rate: 10 M sample /sec
8 bit vertical resolution (25 Lerel/div)
Expanded Timebase 10ms/div - 0.5 s/div.
Refresh, Roll, Save all , Save CH2, Pre-Trig
Plotter Control
250MHz x1, x10 $29, 250MHz x100 $39



DC Power Supply PS-303 $159.00

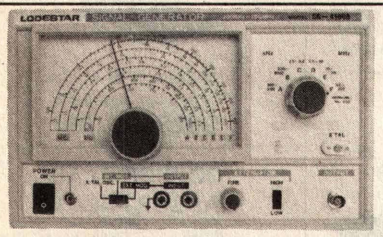
0-30 VDC , 0-3A output

Constant voltage & constant current mode
0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
Short circuit and overload protected
PS-8200 with digital voltmeter $179.00
Also available: 30V/5A, 60V/3A, 60V/5A 16V/10A, 30V/10A



DC Power Supply Triple Output PS-8202 $499.95

Two 0-30 VDC , 0-3A outputs
One fixed 5VDC, 3A output
Capable of independent or tracking operation
Constant voltage and constant current mode
Four digital meters for volt and current display
Excellent regulation and low ripple
Short circuit and overload protected
Also available: 30V/5A triple output $549.95
Dual tracking 30V/3A, 30V/5A, 60V/3A, 60V/5A



RF SIGNAL GENERATOR SG-4160B $119.00

100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz AM modulation
Audio output 1 kHz, 1 Vrms

AUDIO GENERATOR AG-2601A $119.00

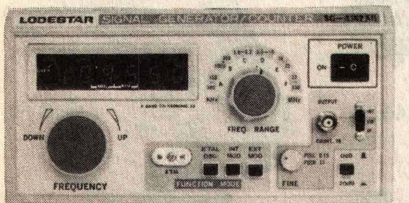
10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sinewave
0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

FUNCTION GENERATOR FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN/ COUNTER FG-2102AD $229.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output



RF SIGNAL GEN./COUNTER SG-4162 AD $229.95

Generates RF signal same as SG-4160B
Frequency counter 1Hz - 150 MHz for internal and external source
Sensitivity <50mV

AUDIO GEN./COUNTER AG-2603AD $229.95

Generates audio signal same as AG-2601A
Frequency counter 1Hz-150MHz for internal and external sources
Sensitivity <50mV

SWEEP FUNCTION GEN./COUNTER $329.95

0.5Hz to 5 MHz in 7 ranges
Sweep: Linear 10:1/Log 10:1 20ms to 2s
AM Modulation
Gated Burst, Voltage Control Generator
Generator Control Voltage & 6 digit counter
1Hz-10MHz for internal & external sources

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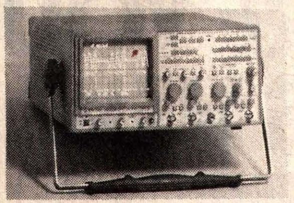
INSTEK® Test & Measuring Instruments

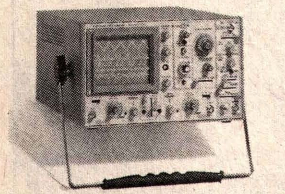
ISO 9002 CERT. #934163

100 MHz Cursor Readout Scope
4 ch, 8 traces OS-6101 $1,499.95



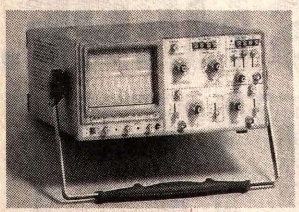
- * 4 independent channels, 8 traces
- * Time /Voltage cursor measurement
- * ALT triggering function for 4 ch.
- * Sweeps to 2ns/div, Delayed Sweep
- * TV Sync., Ch. 1 output, Z-axis input
- * 2 probes(x1, x10)

100 MHz Scope, 4ch. 8 traces
Best value all purpose scope
OS-6100B $1,329.95



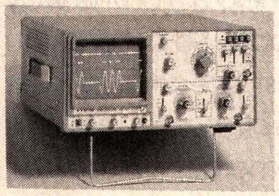
- * 4 channels, 8 traces
- * High sensitivity 500μV/div
- * Sweeps to 2ns/div, Delayed sweep
- * 20 kV accelerating voltage
- * TV sync., Z-axis input
- * A and B gate output
- * Best price 100 MHz scope
- * 2 probes(x1, x10)

50 MHz Triggering Oscilloscope
OS-653 $699.95



- * Dual Channel
- * Hold Off Function
- * Delayed Sweep
- * Built-in Delay Line
- * TV Sync
- * ALT Triggering
- * High sensitivity 1 mV/div
- * Trigger level lock function
- * Z-axis input, CH1 output
- * 2 probes(x1, x10)

20 MHz Oscilloscope
OS-622B $344.95



- * Dual trace, X-Y operation
- * TV Sync., Z-axis input,CH 1 output
- * High sensitivity 1 mV/div
- * Trigger level lock
- * 2 probes (x1, x10)

OS-645B - 40 MHz Cursor readout	$ 734.95
OS-625B - 20 MHz Cursor readout	$ 549.95
OS-623B - 20 MHz w/Delayed Sweep	$ 449.95
OS-935 - 5 MHz One channel	$ 209.95

DC Linear Power Supplies
Single Output

- * Constant voltage and constant current mode
- * Voltage regulation ≤0.01%
- * Current regulation ≤0.2%
- * Low ripple and noise
- * Overload and reverse polarity protection
- * Features 2 analog or 1 digital meter(PS series)
  2 analog or 2 digital meters(PR series)

PS-1830	(0-18V, 0-3A)	$194.95
PS-1830D	Digital Display	$204.95
PS-1850	(0-18V, 0-5A)	$204.95
PS-1850D	Digital Display	$229.95
PS-3225	(0-32V, 0-2.5A)	$199.95
PS-3225D	Digital display	$219.95
PS-6010	(0-60V, 0-1A)	$199.95
PR-1810H	(0-18V, 0-10A)	$329.95
PR-3060	(0-30V, 0-6A)	$299.95
PR-6030	(0-60V, 0-3A)	$299.95
PR-6030D	Digital Display	$399.95

Triple Output DC Power Supplies

- * Two variable 0-30VDC, 0-3A outputs
- * One fixed 5VDC, 3A output
- * Auto tracking
- * Auto serial and parallel operation
- * Constant voltage and constant current mode
- * Continuous/dynamic load can be selected
- * Features 4 analog or 2 digital displays

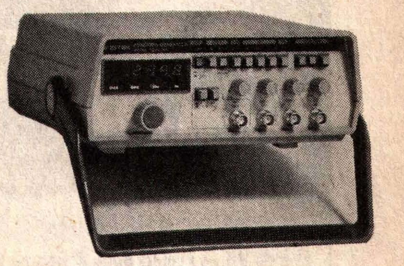
PC-3030	(0-30V, 0-3Ax2)	$479.95
PC-3030D	Digital display	$509.95

Programmable DC Power Supplies

- * High stability , low drift, 4 digit display
- * Front/rear output-sense switch selectable
- * Auto step running w/timer settings
- * 100 point programmability (PPS series)
- * 50 point programmability (PPT series)
- * Auto serial and parallel operation (PPT series)
- * Auto tracking (PPT series), IEEE-488.2 and SCPI compatible command set (optional)

PPS-1860G	(0-18V, 0-6A)	$999.95
PPS-3635G	(0-36V. 0-3.5A)	$999.95
PPS-6020G	(0-60V, 0-2A)	$999.95
PPT-1830G	(0-18V, 0-3Ax2, 0-6V, 0-5A)	$1299.95
PPT-3615G	(0-36V, 0-1.5Ax2, 0-6V, 0-3A)	$1299.95

Digital Display Function Generator
FG-8016G $239.95

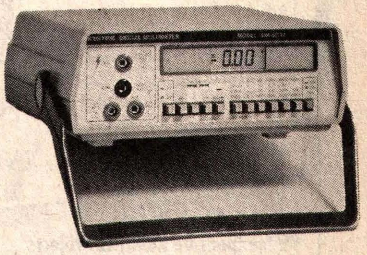


- * Frequency Range: 0.02Hz to 2MHz
- * Three Instruments in one: Function generator, Pulse generator & Frequency counter.
- * Sine, Triangle, Square, TTL Pulse and CMOS output
- * Built-in 6 digit counter with INT/EXT function
- * 1000:1 tuning range
- * Variable DC offset control

FG-8015 Function Generator

* 0.02Hz-2MHz (No Counter)	$189.95
FC-8131 Intelligent Counter 1.3GHz	$469.95
FC-8270 Intelligent Counter 2.7GHz	$599.95
UC-2010G Universal Counter	$289.95

Digital Multimeter & C Meter
DM-8034(3½ digits) $179.95



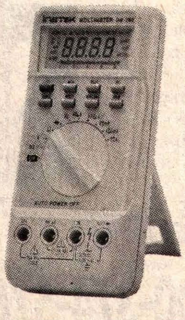
- * 8 Function, AC/DC voltage, AC/DC current, resistance
- * Built-in C meter, diode test and audible continuity check
- * High voltage 1000V and 20A range
- * 0.5% basic accuracy

DM-8040 (3¾ Digits, True RMS)

* Measures ACV to 50 kHz	$339.95
DM-8055 (5½ Digits)	$649.95

- * 0.006% basic accuracy
- * 1μV, 1mΩ, 1nA resolution
- * dBm measurement
- * Auto range, relative mode, Max/Min

DM-8055G(5½ Digits, GPIB)	$889.95



Model DM-392
(3¾ digits) $109.95

- * Auto/Manual ranging(38 ranges)
- * 42 Segment analog bar graph
- * Data Hold/Min-Max memory /Relative mode
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- * Overload protection
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- * **AC True RMS** (DM-394 only)

DM-351	3½ Digits w/Continuity, Auto Off	$54.95
DM-352	3½ Digits, Cap. Freq. hFE, 20 Amp	$79.95
DM-353	3½ Digits, Cap. Freq. Temp. hFE	$84.95
DM-391	3¾ Digits, Auto, Cap. Freq. Min/Max	$99.95
DM-392	3¾ Digits, Hold, Min/Max 20Amp	$109.95
DM-393	3¾ Digits, Peak, Logic, hFE, Freq	$119.95
DM-394	3¾ Digits, TRMS, Same as DM 392	$129.95

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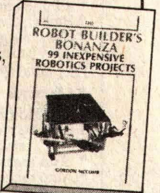
#3-114 $17.95



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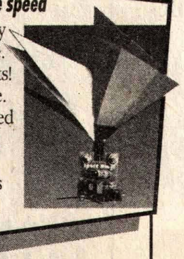

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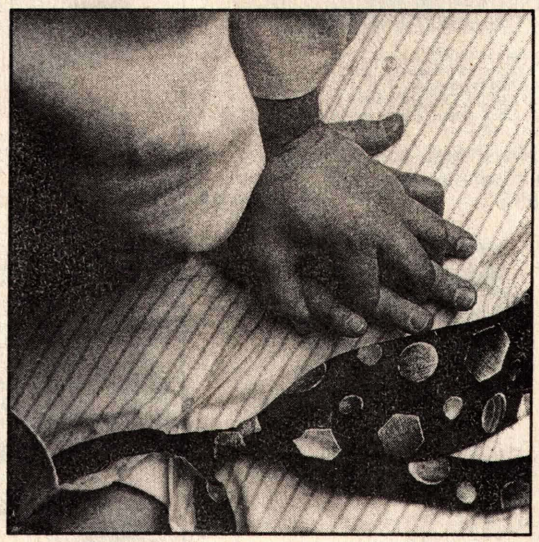

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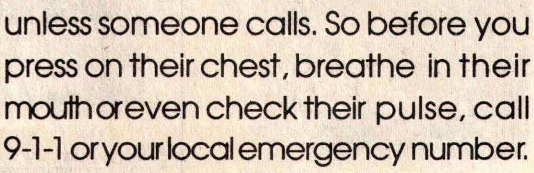

In an emergency, help isn't on the way unless someone calls. So before you press on their chest, breathe in their mouth or even check their pulse, call 9-1-1 or your local emergency number.

Ad Council

To learn more about life-saving techniques, call your Red Cross.

American Red Cross

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PANASONIC TZ-PC 145362	$68	$64	DRX-3 PJ	$37	$33
WAVEMASTER	$65	$60	DRZ-3 PJ	$38	$34
DRZ-3 A & B DUAL INPUT	$39	$35	8528 PJ	$45	$42

CONVERTER/DESCRAMBLERS

	5	10		5	10
8600	$275	$265	DPV-5	$145	$130
8590	$260	$250	DP-5	$125	$110
8580	$195	$185	DRZ-3-DIC	$95	$85
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☐ **YES**, I agree all units are to be used or resold in compliance with Federal and State laws.

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NAME ______________________ ADDRESS ______________________

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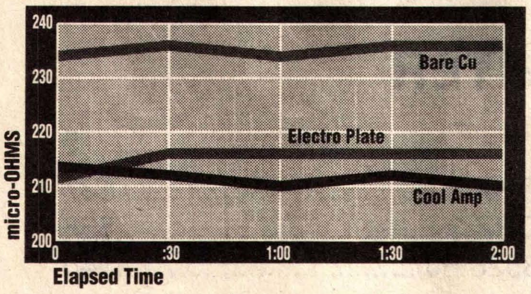
CIRCLE 217 ON FREE INFORMATION CARD

In recent independent tests Cool-Amp is proven better than electroplating.

(For 50 years we've said Cool-Amp is "equal to" electroplating in performance. It is better.)

Cool-Amp

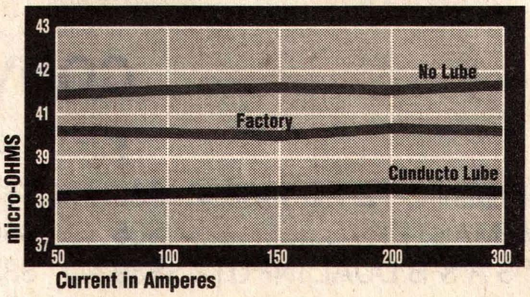


From the report:

"...compare the conducting properties of Cool-Amp silver plating compound with factory silver elctro-plated bus and bare copper bus.

"The test results indicated that the contact resistance of the Cool-Amp plated bus connection was slightly lower than that of the electro-plated bus connection and much lower than that of the bare copper bus connection. The final temperature at temperature equilibrium of the bus connection employing Cool-Amp was slightly lower than that of the electro-plated bus connection and the bare copper bus connection..."

Conducto-Lube



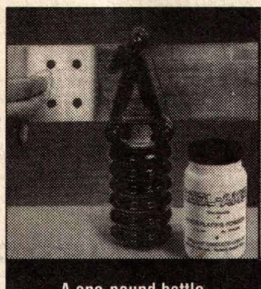
From the report:

"...compare the conducting properties of Conducto-Lube lubricant with factory lubrication and non-lubricated connections on an air switch. Identical test setups and procedures were used for each test so that comparative data could be collected and the relative performance of each type of connection could be quantified.

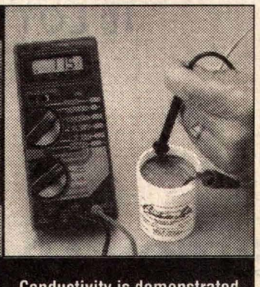
"The test results indicated that the contact resistance of the switch employing Conducto-Lube was generally lower than that of the factory lubricated switch and the switch that used no lubricant."

Cool-Amp How it works:

- Applies *on the job*. Application is simple. Yet Cool-Amp adheres permanently. As tests show, it is better than electroplating.
- Minimizes overheating and power loss by silver plating high amperage connections.
- Saves time, reduces maintenance. Cool-Amp is so simple to apply on the job. It assures maximum conductivity for copper, brass, or bronze contacts and prevents losses due to oxidation.



A one-pound bottle of Cool-Amp silver plating powder plates approximately 6,000 square inches.



Conductivity is demonstrated by inserting test prongs into a container of Conducto-Lube and establishing a circuit. Photo shows low voltage (115 VAC) continuity through container.

Conducto-Lube How it works:

- This is *the* conductive lubricant; highly conductive because it contains pure silver.
- Originally developed to lubricate switches, to the point tension can be adjusted to factory specs allowing full rated capacity of the switch to be maintained at all times.
- Uses have continued to expland–from switches and breakers–to any application where a conductive lubricant is needed.

*Various tests were performed on both products in the Electro-Test, Inc. facilities in Portland, Oregon during January-March, 1994. Evaluation of plating thickness of Cool-Amp was performed by Surface Science Laboratories of Mountain View, California.

COOL-AMP Conducto-Lube

Cool-Amp Conducto-Lube Company
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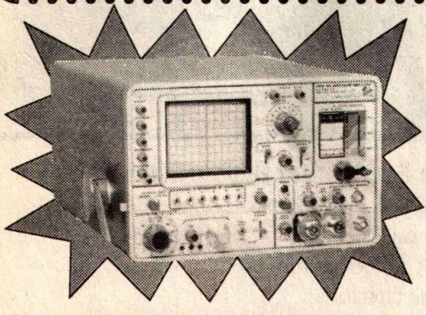
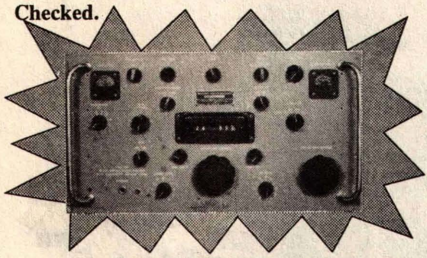


INDUSTRY STANDARD TEKTRONIX 491 SPECTRUM ANALYZER

Covers 10 Mhz - 40 Ghz. Solid state portable unit features internal phase lock, minimum sensitivity is - 100 dBm. A 12.4 Ghz mixer is included with each unit. External mixer kit (40 Ghz) and attenuators are available with purchase of each 491 for $400.00 extra per set. **Price: $1,200.00 ea. Checked.**



R390A RECEIVER

"The **CLASSIC RADIO RECEIVER** that is still a great investment". - These units are complete with ***orig. meters*** and cover the frequency range of 0.5 - 32 Mhz in AM, CW, MCW with direct frequency readout via mechanical digital display -physically complete, less covers.

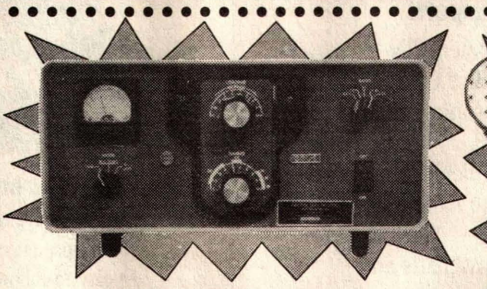
Price: $195.00 Used Repairable

"Just arrived"R-390's. They look to be in pretty good shape (no meters). But still a great investment @ **$165.00 Used Repairable**

COLLINS KWM-2A TRANSCEIVER

A classic HAM 100w tranceiver. These units are true to the classic collins style and quality, built to last more than a lifetime. Limited quantity !!!

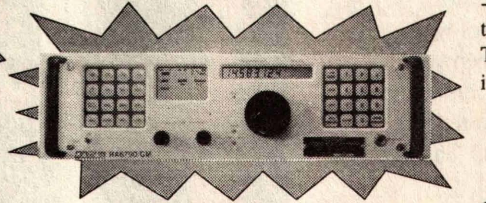
Price: $595.00 with piggyback pwr-supply.
: $445.00 complete as-is w/pwr supply.



COLLINS 30L-1
POWER AMPLIFIER

One of the finest mid-size linear amplifiers ever produced specifically for the Premier Ham Radio Operator. It covers the 80,40,20,15 and 10 meter bands in either SSB, CW, RTTY or SSTV modes. Input drive power is 70-100 watts for full output. Power input is 1200watts, @ 115/230 vac 60 Hz. **Output power** is 650 watts RF (1000w @ reduced duty cycle). These units are in **exceptional** condition complete with cables and connectors. If your looking for the amp opportunity of a life time, you've just checked-in!!!

Price: $695.00 round emblem.



RACAL RECEIVER
RA 6790/GM

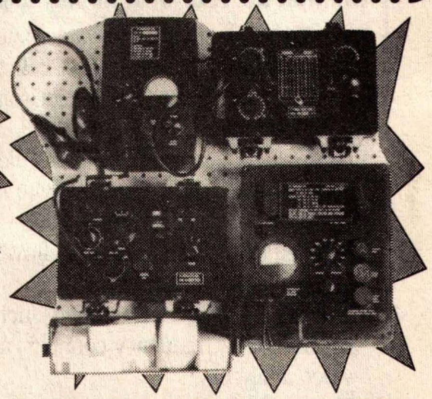
Superior quality and design are standard in this 500Khz-30Mhz general coverage receiver. Modes of operation are AM,FM, CW, U/LSB,ISB -optional, with room for seven bandpass filters. The illuminated LCD display features large readable digits for frequency and mode status as well as AF or RF signal strength.Tuning can be directly entered via keypad or with a tuning knob. Three different gain modes are Manual, Automatic, and Automatic with selectable threshold. Fully Checked & Operational.

Price: $995.00 Radio only-less filters.

Bandpass Filters: 400Hz/1.2KHz/2Khz/6.8KHz 16Khz/USB/LSB are **$65.00 ea.** max 4 per unit.

All Prices in U.S. Dollars
Please include telephone/fax number with mail-in orders.
Orders must be prepaid by guaranteed instrument.

Manuals available at extra cost

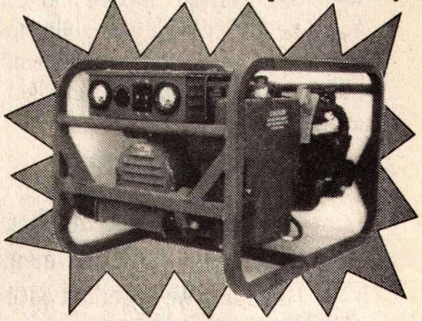


SPECIAL FORCES RADIO SET
R-1004/GRC-109 T-784/GRC-109

"Its a dream come true."Complete GRC-109 radio sets including all the goodies as follows:

- R-1004/GRC-109 Receiver
- T-784/GRC-109 Transmitter
- PP-2684/GRC-109 Power supply (AC,DC)
- PP-2685/GRC-109 Power supply (AC only)
- CN-590/GRC-109 Voltage regulator
  (For hand crank generator)
- Plus Headset, Accessory kit with new spare tubes and parts, original manual and cables.

These are new in the box. A ***FABULOUS*** collector item!! **Price : $350.00 Complete sets only.**



MILITARY STANDARD D.C. GENERATOR

Superior QUALITY plus rugged design are features of this deluxe 2 cylinder 4 stroke gasoline generator.The control panel contains meters for voltage & current indication, main circuit breaker and voltage adjustment.Shielded wires and plugs comprise the RFI suppression ignition system eliminating most radio noise. These units are "**new**" in the original carton complete with operators manual and only require fuel and oil for operation, output voltage is adjustable approx 10-32v (28v nom) @ 53.3A (1.5Kw) continuous duty load. **Price: $295.00 New in Orig Carton. You will be impressed!!!**

Weight =121 lbs. Dim=L 27"xH 18"xW 20"

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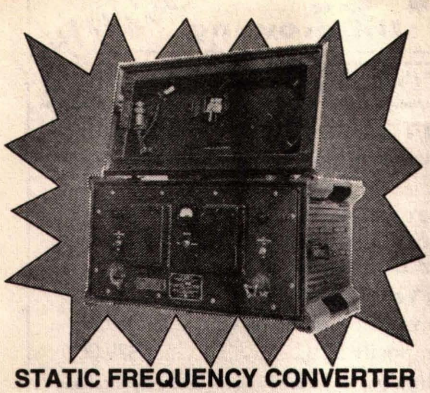
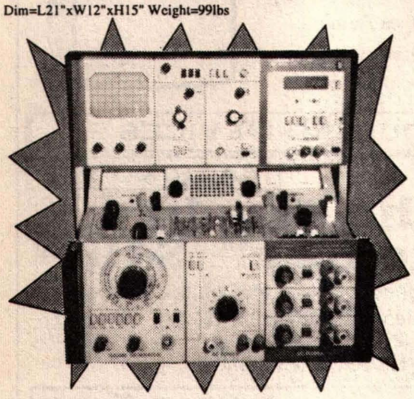


STATIC FREQUENCY CONVERTER

Finally a simple way to power up all that 400 cycle stuff. This is a completely self contained solid state converter that just plugs in to any 115vac 60 Hz power source and provides easy instant 400Hz single phase 115vac output @500 watts. **Price: $395.00 ea. New in Original Carton**
Dim=L21"xW12"xH15" Weight=99lbs



NIDA ELECTRONIC TRAINER

For those of you with limited funds this system provides you with the most essential instruments in one system. It incorporates the following:

- -10MHz oscilloscope
- -Autoranging DVM
- -Function generator
- -"3" variable dc power supplys
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- -Precision decade resistance
- -Speaker and 2 analog meters

This unit comes complete with a number of electronic experiments assembled on easy to use plug-in cards. **Price: $365.00**

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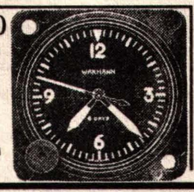
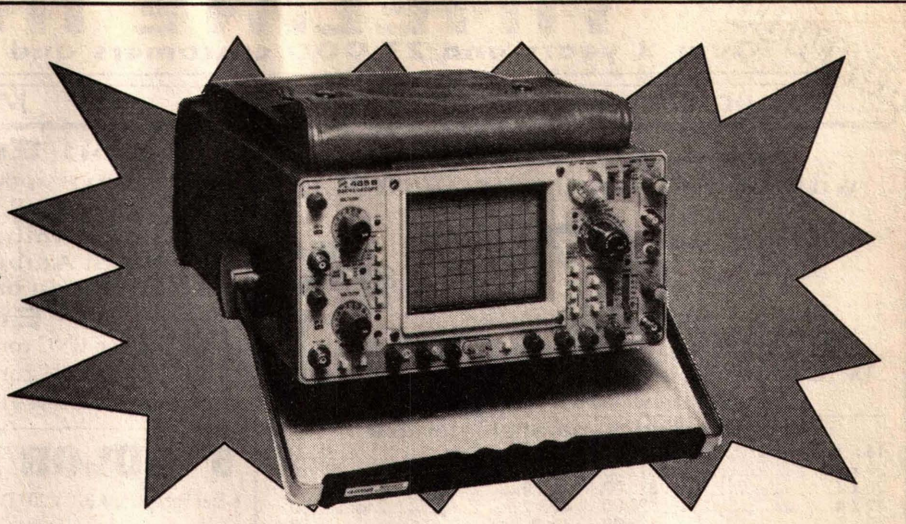
8-DAY AIRCRAFT
CLOCK
1-7/8" dial
Great collectors item for the ham shack, fifties vintage funct/chkd.





TEKTRONIX 465B

Proof is in the pudding when it comes to this instrument's track record. There's no doubt, that popularity speaks many languages when speaking of the "465B". This excellent instrument continues the tradition of the standard 465 oscilloscope by adding useful features such as CH-1, CH-2 sum or difference, trigger view in any combination, alternate sweep and trace selection versatility. Many technicians dream of owning a quality 100-MHz oscilloscope, but funding rairly permits. Fortunately, we were recently able to aquire a limited supply of 465B-s in nearly *new* condition. Our LOW PRICES will likely permit "you" to own one of the best scopes anywhere in the country. If your needs are current and action *swift* you too will be a member of a growing club!!!

SELECTED EXCELLENT COND......$849.00
VERY GOOD CONDITION.................$695.00

These instruments are fully checked out and calibrated. They are supplied with an original front panel cover and complete service manual. Original TEK Probes are $75.00 each with each purchase.

MARCONI SYNTHESIZED SIGNAL GENERATOR

Model 2018

Freq range 80Khz-520Mhz with calibrated output levels from -127 dBm to +13dBm. Resolution 10Hz. It can be freq, phase or amplitude modulated from ext or int modulation sources. RF output resolution is 0.1dB, reversepower protection of up to 50W is possible without damage to the instrument. This instrument is microprocessor controlled and very easy to use, a must for any serious repair or development lab.**Price : $1750.00 Checked**

PDR-63 PORTABLE RADIAC METER

This portable radiac set is loaded with all kinds of extras featuring six ranges of sensitivity for both Gamma or Beta radiation measurements. The 1st scale 0-1 rad/hr up to 0-5000 rad/hr.The unit comes supplied with headset & bat/charger. Req's only 4 AA Batteries. **Price: $149.95**

HP 8565A SPECTRUM ANALYZER .01-40GHz	$6250.00
HP 8558A SPECTRUM ANALYZER .01-1.5GHz	$2750.00
HP 8559A SPEC-ANALYZER .01-22GHz	$4995.00
HP 8160A OPT-20 PROG PULSE GEN	$3995.00
HP 4260A LCR BRIDGE	$ 385.00
HP 3551A TRANSMISSION TEST SET	$ 950.00
EXACT 566 SWEEP/FUNCTION GEN	$ 345.00
BOONTON 82AD AM/FM MOD-METER	$1275.00
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TIMELINE INC.

Over 8 years and 23,000 customers and still growing.

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160 x 128 dot LCD with Built-in controller. (T6963C)

20 character x 16 line capability.

$79.00 **2 for $149.00**

Mfr: Toshiba TLX-1013-EO.
Unit is EL back-lit. Dim: 5" 1/16 L x 4" 1/16 H.
The built-in controller allows you to do text and graphics without adding an additional controller card.

Alphanumeric—parallel interface

16 x 1	3 for $25.00	**16 x 2**	$8.00
20 x 2	$12.00	**16 x 4**	$25.00
20 x 4	$25.00	**24 x 2**	$12.00
32 x 4	$20.00	**40 x 2**	2 for $25.00
40 x 4	$25.00	**4 x 2**	$5.00

5V power required • Built in C-MOS LCD driver & controller • Easy "Microprocessor" interface • 98 ASCII character generator • *Certain models are backlit, call for more info.*

Graphic and alphanumeric—serial interface

Size	Mfr.	Price
640 x 480	Epson	$50.00
640 x 400 *(backlit)*	Panasonic	$35.00
640 x 200	Toshiba	$19.00
480 x 128	Hitachi	$15.00
256 x 128	Epson	$25.00
240 x 128 *(backlit)*	Optrex	$20.00
160 x 128	Optrex	$15.00

LASER PRODUCTS

HeNe Laser Head (10Mw max. output) TEMOO, 15.5" long MFG:NEC **$99.00**
Laser Power Supply (for HeNe tube) **$100.00**

LASER SCANNER ASSEMBLY $29.00
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

LASER DIODE (5mW) **with collimator $20.00**

LASER DIODE: **Sharp part#: LT022MC**
5mW at 780 nm. single transverse mode **$10.00**

NETWORK

IRMA BOARD 8 bit $99.00
Links 3270 mainframe systems to IBM PC

Proteon ProNet-4 Model pl347 Token Ring Board $79.00
16 bit • 4 Mbps • IEEE 802.2 and 802.5 compatible • twisted pair • interoperable with IBM Token Ring network

POS & BAR CODE

MAGNETIC CARD READER $25.00
Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.

HP bar code wand (HBCS 2300)................$35.00

POWER SUPPLYS

73 WATT SWITCHING $15.00 or 2 @ $25.00, (2) 4 pin power connectors attached • 115/230 Volt, Dim: 8.5" L x 4.5" W x 2" H • Output: +5V @ 2-9.75 A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A

68 WATT SWITCHING $12.00 or 2 for $20.00, 115/230 Volt, Dim: 5.5" L x 3.2" W x 1.7" H • Output: 5V @ 4 A, 12V @ 4A

MISCELLANEOUS

ADAPTEC 4070A (RLL) OR 4000A (MFM) SCSI Controller, your choice $40.00

IBM 370 option XT and AT emulation boards $50.00

MONITORS

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input. Horizontal frequency 15 Khz. Ability to do 40 and 80 column.

5 inch Black & White.........$35.00
7 inch Amber.......................$39.00
9 inch Amber.......................$29.95
12" Green or B & W...........$19.95

Enclosed

9" Green BNC composite 115V/230V $69.00
12" White BNC composite 24V..........................$79.00

Mfr.: Electrohome • For Very High Quality Medical and Industrial Applications

5" COLOR MONITOR $69.00

2 for $109.00

- Flat Faceplate • 320 x 200 Dot Resolution
- CGA & Hercules Compatible
- 12 VDC Operation • 15.75 KHz Horiz. Freq.
- 60 Hz Vert. Sync. Freq. • Open Frame Construction • Standard Interface Connector
- Degaussing Coil Included • *Mfg.: Samtron*

CHARGE COUPLED DEVICES

MATRIX TYPE

"The Spy In The Sky" $49.00

Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V)

Chip size 10.7 (H) x 9.3 (V) mm^2 • Unit cell size 23.0 (H) x 13.4 (V) um^2 • Ceramic 24 pin DIP package. • Mfr: Sony, Part# 016AL

LINEAR TYPE

4096 element CCD $29.00
2048 element CCD $15.00 • 1728 element CCD $15.00

HACKER CORNER

Proxim — Spread Spectrum RF Modem $99.00

The Proxlink is a small communication device that replaces the use of a RS-232 cable hook-up with wireless (Radio Frequency) technology. Each module combines the functions of an RS-232 compatible modem (or any other RS 232 device) and a transmitter/receiver operating in the 902-928 MHz band. Indoor range of up to 500 feet possible using standard 1/4 wave antenna. Units support data rates up to 19.2 KBaud (full duplex) and uses multiple channels to allow for non-interfering overlapping systems. Message format is 8 data bits, no parity, and 1 stop bit. Each unit requires 5 VDC supply at a maximum of 230 mA. A wide variety of configurations can be accommodated with parameters stored in non-volatile memory (EEPROM). Configuration changes are supported by menu driven, on-board software. Installation schematics and application details are available. Original cost on these units is around $600.

Portable Micro Terminal

Flip up LCD display (9-16 VDC) • Can communicate with any computer having RS 232 port • Can communicate with another Microterminal • Use by itself as electronic notebook • Onboard microprocessor, data RAM (32K) and Video RAM (64K) • Complex built in diagnostics and set up capabilities. • Original intention for POS applications. • display size 40x16 (256 x 128 pixels.) Dimensions: 6.3" W, 11"L, 2"H. (With LCD up height is 7.1")

$99.00 **or 2 for $149.00**

All in one 286 board $29.00

Includes: • 286-12Mhz CPU (1 wait state) • Built in IDE & floppy controller • 80287 math coprocessor socket • FAST! on board SVGA with 256K RAM • 2 serial ports, 1 printer port, mouse port • EMS-LIM ver 4.0 memory & shadow RAM support • Up to 8 mb memory (256K or 1 Mb SIMMS) • Comes with 0K on board • On board speaker • REAL TIME CLOCK • Phoenix BIOS • Note: There is one long non standard bus connector on board

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CIRCLE 275 ON FREE INFORMATION CARD

CircuitMaker® vs. Electronics Workbench®

A NEW STANDARD HAS JUST BEEN SET !

State-Of-The-Art Analog Simulation

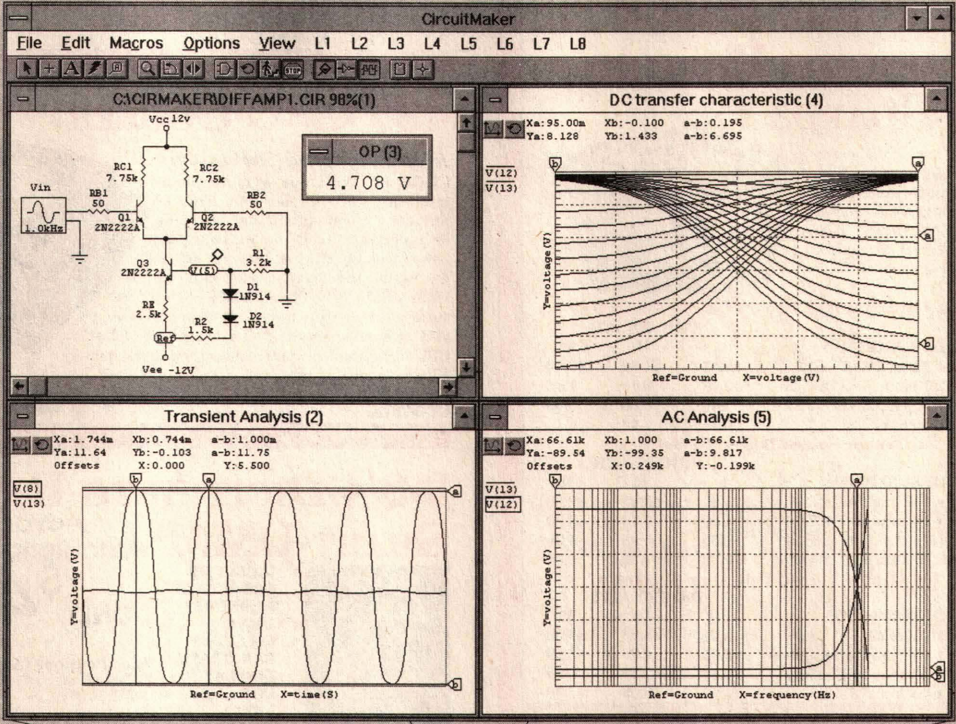
CircuitMaker's analog simulation results are shown in graph windows that provide powerful, interactive analysis options. You can plot multiple waveforms by clicking on the desired nodes and can select linear or logarithmic axes. Horizontal and vertical cursors facilitate quick and accurate measurements. You can also zoom in on any portion of the graph to obtain additional detail.

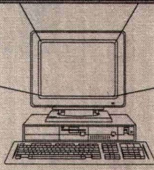
Electronics Workbench offers a single, small scope or Bode plot instrument window. The windows are not sizeable and only two waveforms can be plotted at a time. EWB has a single measurement cursor and provides no direct way to read results from the instruments.

Superior Digital Simulation

CircuitMaker has an exclusive Trace feature where the state of every node is indicated in color as the simulation runs. You can monitor as many waveforms as your screen will allow, set edge or level breakpoints for analysis, and interactively see the state of any node by touching the logic probe to it. The data sequencer provides 1024 words of pattern data. Additional digital instruments include ASCII and HEX input keys and an ASCII display. CircuitMaker includes tri-state devices and devices have programmable propagation delays.

Electronic Workbench has no interactive logic probe or Trace capability and no Hex or ASCII keys. Their "word generator" is limited to 16 words. EWB does not have tri-state devices and digital devices do not have programmable propagation delays.


CircuitMaker
File Edit Macros Options View L1 L2 L3 L4 L5 L6 L7 L8
C:\CIRMAKER\DIFFAMP1.CIR 98%(1)
Vcc 12V
RC1 7.75k
RC2 7.75k
Vin
1.0kHz
RB1 50
Q1 2N2222A
Q2 2N2222A
RB2 50
Q3 2N2222A
V(5)
R1 3.2k
D1 1N914
D2 1N914
RE 2.5k
R2 1.5k
Ref
Vee -12V
OP (3)
4.708 V
DC transfer characteristic (4)
Xa:95.00m Xb:-0.100 a-b:0.195
Ya:8.128 Yb:1.433 a-b:6.695
V(12)
V(13)
Y=voltage(V)
Ref=Ground X=voltage(V)
Transient Analysis (2)
Xa:1.744m Xb:0.744m a-b:1.000m
Ya:11.64 Yb:-0.103 a-b:11.75
Offsets X:0.000 Y:5.500
V(8)
V(13)
Y=voltage(V)
Ref=Ground X=time(S)
AC Analysis (5)
Xa:66.61k Xb:1.000 a-b:66.61k
Ya:-89.54 Yb:-99.35 a-b:9.817
Offsets X:0.249k Y:-0.199k
V(13)
V(12)
Y=voltage(V)
Ref=Ground X=frequency(Hz)



Comprehensive Device Libraries

CircuitMaker includes libraries containing programmable, TTL, CMOS, generic analog and digital devices, and many powerful I/O devices. With CircuitMaker's macro function you can quickly and easily create your own functional devices and symbols. Now that's giving you the tools you need to get the job done right!

Electronics Workbench ships with only 17 digital devices. If you want additional devices you pay extra.

Competitive Upgrade Offer

You deserve the best. Upgrade from any competing product for only $99. New users can purchase CircuitMaker for a limited time at a special introductory price of just $269. Suggested Retail Price $299.

High-Performance Schematic Capabilities

CircuitMaker puts you in control of your schematic with SmartWires™, bussing, page connectors, and rubberbanding. You can label devices and pins, add fully stylized multi-line text, and create a parts list or netlist. With the Macro feature you can add user defined symbols to your device library.

Electronics Workbench dictates wire placement to you. EWB limits your overall "workbench" layout to 1 x 2 pages. EWB has no bussing, page connectors, pagebreaks, print scaling, labeling, free text fields, netlisting, zoom, undo, and no Toolbar or Toolbox.

Technical Support

MicroCode Engineering offers free phone support from knowledgeable engineers. And, you won't find yourself listening to music when you call for help.

Interactive Image Technologies offers 3 free calls and then you have to pay for all subsequent calls.

Comparison based on CircuitMaker 2.0 for Windows and Electronics Workbench 3.0 for Windows. All product and company names are trademarks of their respective owners.

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ETCHING TANK

This attractive injection moulded designed tank is ideal for etching your PCBs. It includes a thermostatically controlled glass heater, electric agitator and PCB hanging accessories. Measuring graduations are included. Maximum PCB size is 160mm x 250mm or 200mm x 250mm w/o heater. Typical etching time is 4 minutes.

CAT NO	DESCRIPTION	PRICE
ET10EN	Etch Tank System	$48.00

POSITIVE PHOTO RESIST PRE-SENSITIZED PRINTED CIRCUIT BOARDS

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CSI PART#	DESCRIPTION	PRICE EACH 1	10	50
PP101EN	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114EN	114mm x 185mm/4.49" x 7.28"	2.98	2.45	1.98
PP152EN	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153EN	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

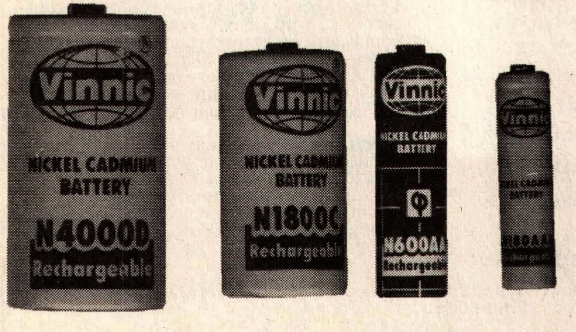
CSI PART#	DESCRIPTION	PRICE EACH 1	10	50
GS101EN	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114EN	114mm x 185mm/4.49" x 7.28"	4.80	3.49	3.20
GS152EN	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153EN	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CSI PART#	DESCRIPTION	PRICE EACH 1	10	50
GD101EN	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114EN	114mm x 185mm/4.49" x 7.28"	5.95	4.29	3.99
GD152EN	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153EN	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30

NI-CAD BATTERIES

AS LOW AS .89 EACH



These sealed Nickel Cadnium batteries are PVC jacketed. Re-chargeable Ni-Cad batteries provide much better cost/performance ratios than traditional alkaline or carbon batteries and now Circuit Specialists offers great prices on selected Ni-Cads to make your savings even greater!

CSI PART#	SIZE	AMP/HR	VOLTAGE	PRICE EACH 1	10	25	100
N720AAEN	AA	720	1.2	$1.69	$1.39	$1.09	$ .97
N180AAAEN	AAA	180	1.2	1.49	1.30	.99	.89
N1800CEN	C	1800	1.2	3.15	2.64	2.25	1.98
N4000DEN	D	4000	1.2	5.40	4.53	3.88	3.40

ETCHING CHEMICALS

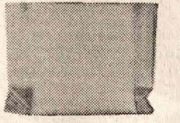
FERRIC CHLORIDE

DIRECT ETCH

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CSI PART#	DESCRIPTION	PRICE EACH 1	5
ER-3EN	Makes 1 pint	$3.50	$2.75

DEVELOPER



This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CSI PART#	DESCRIPTION	PRICE EACH 1	10	25
POSDEVEN	Positive Developer	$ .95	$ .80	$ .50

486 CPU COOLER

Increase Performance! Prolong Life!

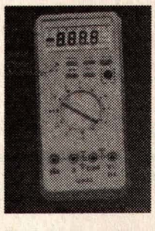
COOL IT! With our easy to install miniature CPU Cooler Fan. This kit includes an omni-directional heat sink, long-life, low noise, DC fan with ready to go power hook-up. The best low-cost, high add-on value investment you can make! PERFORMANCE: Typical 80486-33MHz CPU surface temperature reduces from approximately 79°C to approximately 48°C. Typical 80486-50MHz CPU surface temperature reduces from approximately 95°C to approximately 54°C.

CSI PART#	PRICE 1	5
CC-M3EN	$10.95	$9.95

3-3/4 DIGIT AUTO-RANGING SMART DMM

Advanced Auto-Ranging DMM

ONLY $49.00



- *INCLUDES FREQUENCY MEASUREMENT!*
- *INCLUDES BAR GRAPH DISPLAY!*
- *INCLUDES hFE!*
- *INCLUDES CAPACITANCE CHECK!*

This is certainly one of the finest values in an advanced DMM design that we have ever seen. Advanced features make this a good choice for engineers & technicians. Affordable price for schools & students. Don't let the low price fool you. Quality is as good or better than meters costing twice as much! This is an excellent value & includes a 1 year limited warranty from Circuit Specialists.

Features:

- Full Autoranging Measurement
- 0.3% Basic Accuracy (DCV)
- 3-3/4 Digit LCD Display (4000 count)
- Bar Graph Display
- Min/Max Mode, Data Hold Mode
- Relative, Memory, Read Modes
- Frequency Measurement up to 1000KHz
- Continuity Beeper and Diode Test
- Auto and Manual Ranging Selection
- hFE Check
- Capacitance Check up to 40uF
- Symbolic Signs at all Ranges

CSI PART#	DESCRIPTION	PRICE
9303EN	3-3/4 Digit Auto-Ranging DMM	$49.00

Specifications (Autoranging)

DCV Range : 400mV, 4V, 40V, 400V, 1000V
Resolution : 0.1mV, 1mV, 10mV, 100mV, 1V
Accuracy: +-(0.3%rdg.+-1dgt)
Input Impedance100Mohm, 10Mohm
ACV Range: 4v, 40V, 400V, 750V
Resolution: 1mV, 10mV, 100mV, 1V
Accuracy: +- (1.0%rdg.+10dgts) (50-500Hz)
Input Impedance: 10Mohm
DCA Range: 4mA, 40mA, 400mA, 4000mA, 10A
Resolution: 0.001mA, 0.01mA, 0.1mA, 1mA, 0.01A
Accuracy: +-(1.5%rdg.+2dgts)
ACA RangE: 4mA, 40mA, 400mA, 4000mA, 10A
Resolution: 0.001mA, 0.01mA, 0.1mA, 1mA, 0.01A
Accuracy: 4mA-4000mA +-(2.0%rdg.+8dgts) 10A+-(1.5%rdg.+8dgts)
OHM Range: 400 W, 4KW, 40KW, 400KW, 4MW, 40MW
Resolution : 0.1W, 1W, 10W, 100W, 1KW, 10KW
Accuracy: 400W+-(1.0%rdg.+2dgts) 4KW-4000KW+-(0.8%rdg.+3dgts) 40MW+-(2.0%rdg.+5dgts)
F Range: 100Hz, 1000Hz, 10KHz, 1000Kz, 1000KHz
Resolution: 0.01Hz, 0.1Hz, 1Hz, 10Hz, 100Hz
Accuracy: +-(0.8%rdg.+8dgts)
C Measures 4nF, 40nF, 400nF, 4uF, 40uF
hFE lb=10uA Vce=2.8V hFE<4000
Diode Open circuit voltage around 3V
Continuity check by beeper at approx.<40Ohms
Dimensions & Weight: 185(L) x 85(W) x 34(H) mm, 500g.

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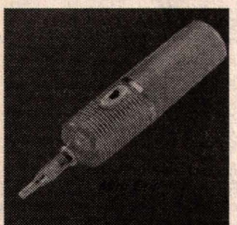
PLCC EXTRACTION TOOL

PLCC EXTRACTION TOOL

CAT NO	PRICE EACH 1	10	100
08-610EN	$4.95	$3.80	$3.16

INDUSTRIES LOWEST PRICE!

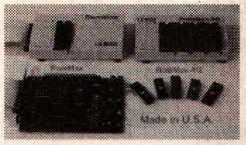


MINI DRILL

Suitable for Most Light Drilling Applications especially Circuit Board Drilling. Runs on 4 "AA" Batteries or Optional 6V AC Power Supply. Includes 4 Drill Bits (0.8mm, 1.0mm, 1.2mm, 1.6mm) and runs at 2500RPM's.

CAT NO	DESCRIPTION	PRICE EACH 1	10
908-398NEN	Mini Drill	$29.88	$25.88

ROMMAX & ROMMAX-4G



E (E) PPROM & Microcontroller Programmers

General Features

- Programs all EPROMs, EEPROMs, Including High-Speed Flash Memories up to 8 Megabytes
- Programs Microcontrollers with Adapters
- Multiple Device Programming (RomMax-4G)
- Reliable and Fast Programming with Intelligent, Quick Pulse and Flash Programming Algorithms
- User-Friendly Menu-Driven Software with 'Help' Mode
- Supports Binary, Intel Hex, Motorola S and Tektronix Hex File Formats
- Self-Tests: Communications, Pin Driver Tests and timing
- Comes with Complete Software, Programming Module, 40 Pin Ribbon Cable and Manual
- One Year Warranty Covers Parts and Labor
- Free Software Updates via BBS
- **Made in U.S.A.**

Device Support

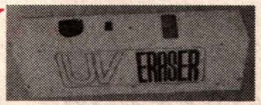
- NMOS/CMOS EPROMs (2716...27C040)
- EEPROMs (2816...28010)
- Page Mode EPROMs (27C513, 27C011)
  Flash E(E)PROMs (28F256...28F020)

Device Support with Adaptor

- 16 Bit (40 Pin) E(E)PROMs
- Microchip PIC16C5x Series
- NS COP Microcontroller Series
- 87C51, 87C52 Series (AMD, Intel)
- 87C751, 87C752 (Signetics)

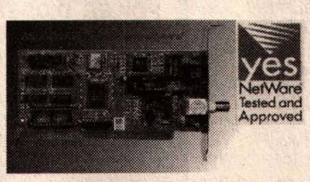
CAT NO	DESCRIPTION	PRICE
ROM MAXEN	PC Based E, E(E)PROM Programmer	$129.00
ROM MAX-4GEN	With 4 Sockets	179.00
	ADAPTORS	
RM-16BITEN	40 Pin Socket for 16 Bit EPROM	85.00
RM-875XEN	For 875 x Micro Series	95.00
RM-PIC16C5XEN	For PIC 16C6X Micro Series	95.00

HIGH CAPACITY EPROM ERASER



ERASE UP TO 30 EPROMs AT ONE TIME! Load this EPROM Eraser with up to 30 pcs. of 24-pin EPROM (24pcs. of 28-pin) at one time. Erases in 15 min. and includes a convenient timer for worry free operation. Timer setting is from 0 to 60 min. • 60 min. Timer w/Bell • 30 pc. Capacity, 24-pin • 24 pc. Capacity, 28-pin • Power Rating: 11,000μW/cm^2 • Power: 110V AC, 10 Watts

CAT NO	DESCRIPTION	PRICE
AT-101EN	High Capacity EPROM Eraser (Supply Limited)	$99.00



16-BIT ETHERNET CARD/2-WAY COMBO DESIGN (BNC/RJ-45/AUI)

Fully Novell NE2000 compatible (no software drivers required). Here is an outstanding value for your ETHERNET Network solutions.

- Provides BNC & RJ-45 Interface Connections for Maximum Wiring Flexibility (BNC-T Adaptor Included in Box)
- Fully Complies with IEEE 802.3 Industry Standard with 10MB/Sec Data Transmission Rate
- Supports Bus & Star Topologies
- Selectable Interrupts (IRQ2-5 and 10, 12, 15)
- Hardware Compatible to NE2000. No Software Drivers are Required to Obtain NE2000 Compatibility
- Diagnostic LED's on Rear Bracket Permits Easier Installation and Assists in Troubleshooting & Network Monitoring
- Designed with Remote Boot ROM Socket for No Disk Drive Configurations

CAT NO	DESCRIPTION	PRICE EACH 1	6
NETE16CEN	2-Way Combo Ethernet Card	$49.00	$45.00
BOOTROM-3.11EN	Optional Boot Rom for Netware 3.11	14.50	13.00
BOOTROM-3.12EN	Optional Boot Rom for Netware 3.12	14.50	13.00

16 Port 10BASE-T Hub
12 Port 10BASE-T Hub
Mini Hub

ETHERNET 8 PORT 12 PORT 16 PORT 10BASE-T HUBS

Now you can easily install your 10BASE-T system with our selection of 10BASE-T Hubs. They can be linked together as you expand to build an even larger Ethernet Network without disturbing the existing network.

FEATURES

- Supports up to 8, 12 or 16 10BASE-T Workstations
- Conforms to IEEE 802.3 10BASE-T Specifications
- Equipped with Diagnostic LED's
- Includes 1 BNC and 1 AUI Port in Addition to the RJ-45 Ports (8 Port Includes BNC only)
- Maximum Length of Twisted Pair Cable Segments is 100 Meters

CAT NO	DESCRIPTION	PRICE EACH 1	3
ETHER-H9+EN	Mini Hub with 8 RJ-45 & 1 BNC Port	$213.00	$198.00
ETHER-H12+EN	10BASE-T Hub with 12 RJ-45, 1 BNC & 1 AUI Port	392.00	364.00
ETHER-H16EN	10BASE-T Hub with 16 RJ-45, 1 BNC & 1 AUI Port	463.00	425.00

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7818.........47¢
7824.........47¢
7905.........50¢
7908.........50¢
7912.........50¢
7915.........50¢
LM317T ...80¢
78L05.......34¢
78L12.......34¢

Deal 'J1': 10pcs (5 ea of 78L05 & 78L12)....**$3**

1 W ZENER DIODE

1N4728A.....3.3V......6¢
1N4733A.....5.1V......6¢
1N4739A.....9.1V......6¢
1N4742A..... 12V ......6¢
1N4744A..... 15V ......6¢
1N4746A..... 18V ......6¢

Deal 'Z5': 30 pcs total, (5pcs of each)...........**$2**

POPULAR CMOS

CD4001B .....25¢
CD4011B .....25¢
CD4013B .....35¢
CD4017B .....35¢
CD4028B .....35¢
CD4066B .....35¢
CD4069B .....35¢

Deal 'V2': 14 pcs total, (2pcs of each)...........**$4**

RADIAL 'LYTICS

1uF/50V ....5¢
2.2uF/50V ......5¢
3.3uF/50V ......5¢
4.7uF/50V ......5¢
10uF/25V ....5¢
22uF/25V ....5¢
33uF/25V ....6¢
47uF/25V ....6¢
100uF/25V .....8¢
220uF/25V .....8¢
330uF/25V .....9¢
470uF/25V ...10¢

Deal 'A9': 60 pcs total, (5pcs of each)...........**$4**

I.C. SOCKETS

	Solder Tail	Machine Wire Wrap
8 pin	4¢	30¢
14 pin	7¢	54¢
16 pin	8¢	62¢
18 pin	9¢	70¢
20 pin	10¢	78¢
24 pin	12¢	94¢
28 pin	14¢	1.10
32 pin	16¢	1.24
40 pin	20¢	1.56

POPULAR I.C.s

LM324 .....45¢
LM339 .....45¢
LM358 .....45¢
NE555 .....40¢
NE556 .....45¢
LM741 .....40¢

Deal 'U3': 12 pcs total, (2pcs of each)...........**$5**

DIODES

1N914A ....3¢
1N4148 ....2¢
1N4001 ....1A/50V .....3¢
1N4004 ...1A/400V ....4¢
1N4007 ....1A/1kV .....5¢

Deal 'P7': 50 pcs total, (10pcs of each).........**$2**

POWER DIODES

1N5401 ...3A/100V ....6¢
1N5404 ...3A/400V ....7¢
1N5408 ....3A/1kV .....8¢
6A10........6A/100V ..20¢
6A100.......6A/1kV ...30¢

Deal 'H8': 25 pcs total, (5pcs of each)...........**$2**

1 AMP SCHOTTKY

1N5817 ....1A/20V ...20¢
1N5818 ....1A/30V ...23¢
1N5819 ....1A/40V ...24¢

Deal 'Y4': 9 pcs total, (3pcs of each)...........**$2**

3 AMP SCHOTTKY

1N5820 ....3A/20V ...32¢
1N5821 ....3A/30V ...36¢
1N5822 ....3A/40V ...40¢

Deal 'Y9': 9 pcs total, (3pcs of each)...........**$3**

CERAMIC DISC

(All caps rated 50V)

10pF ....5¢
22pF ....5¢
27pF ....5¢
33pF ....5¢
47pF ....5¢
100pF ....5¢
150pF ....5¢
220pF ....5¢

Deal 'R4': 40 pcs total, (5pcs of each)...........**$2**

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Miniature size
1/4" Panel hole

on-on .... SPDT ....60¢
on-on .... DPDT ....68¢
on-off-on ... DPDT ....85¢

Deal 'S7': 6 pcs total, (2pcs of each)...........**$4**

TANTALUM CAPS

1uF/35V ....18¢
2.2uF/35V ....20¢
10uF/35V .....35¢

Deal 'T6': 15 pcs total, (5pcs of each).....**$3.50**

Germanium Diodes

1N34A ....10¢
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470pF ....5¢
.001uF ....5¢
.01uF ....5¢
.022uF ....5¢
.047uF ....6¢
.1uF ....6¢

Deal 'R7': 40 pcs total, (5pcs of each)...........**$2**

1/4W 5% Resistors

10, 47, 100, 470, 1K, 4.7K,

Deal 'W2': 120pcs total, (20pcs ea. above)......**$2**

10K, 47K, 100K, 470K, 1M

Deal 'W5': 100pcs total, (20pcs ea. above)......**$2**

MONO CAPS.....5¢ea

.01uF/50V .047uF/50V
.022uF/50V .1uF/50V

Deal 'B5': 40 pcs total, (10pcs of each).........**$2**

T1 (3mm) Diffused LEDs

Red.............6¢
Green ....7¢
Yellow..........8¢

Deal 'L6': 30 pcs total, (10pcs of each).........**$2**

TRANSISTORS

PN2222A.....5¢
PN2907A.....5¢
2N3904........5¢
2N3906........5¢
2N4401........5¢
2N4403........5¢

Deal 'N8': 60 pcs total, (10pcs of each).........**$3**

More Transistors

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2N4124........8¢
2N4126........8¢
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MPSA13 ....14¢
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MPSH10 ....10¢
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TIP125.......50¢

T1 $3/4$ (5mm) Diffused LEDs

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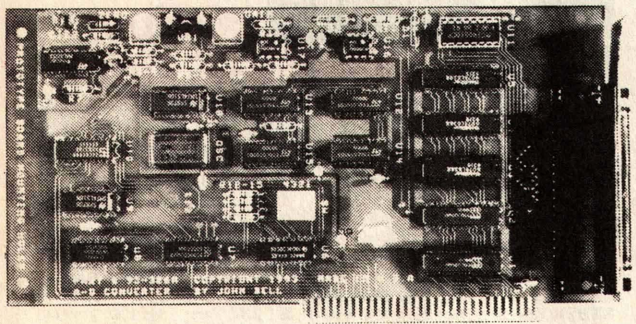

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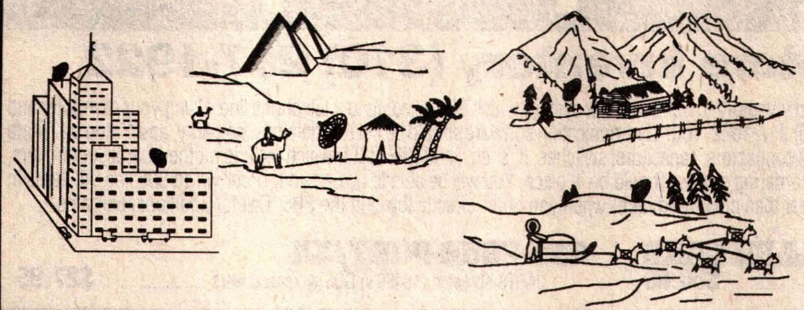

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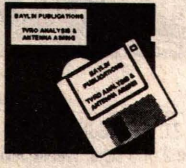

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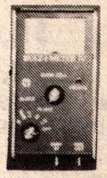

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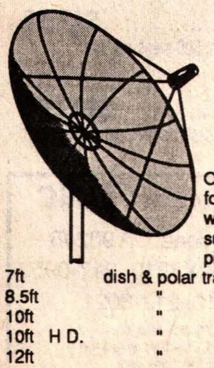

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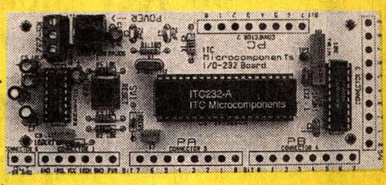

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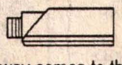

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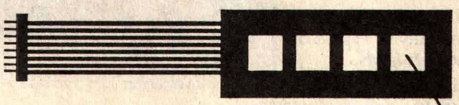

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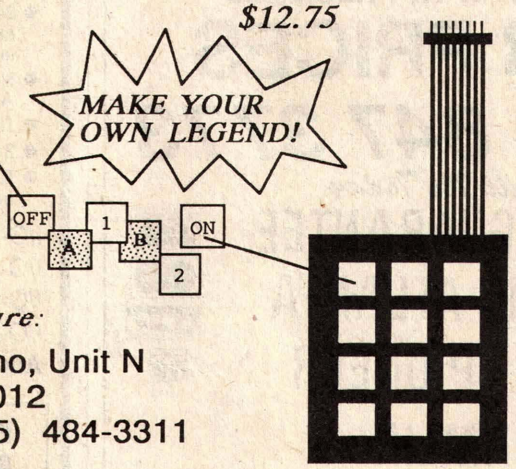

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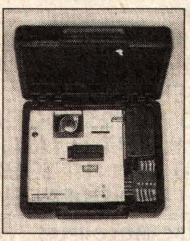

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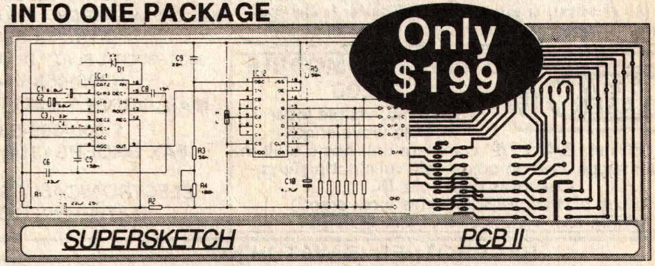

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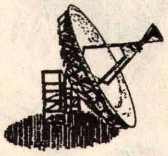

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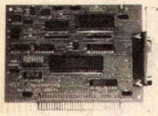

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- 400 Khz sampling

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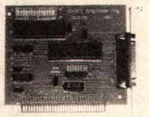

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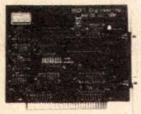

- 8 Channel 8-Bit 0 to 5 Volt input
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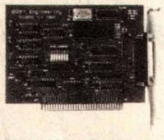
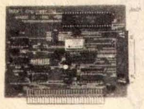
- 400 Khz sampling

DIG200 Counter I/O........ $ 79



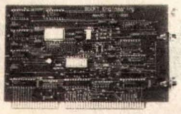
- 3 16-Bit Counters
- 8-Bit input port
- 8-Bit output port
- Selectable Clock frequency input

ANA200 Analog I/O.............. $ 79



- 1 Channel 12-Bit 0 to 5 Volt input optional bi-polar
- 100 Khz sampling
- 24 TTL I/O lines

ANA201 Analog .... $ 129



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- 100 Khz sample

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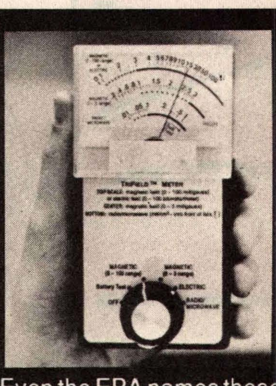

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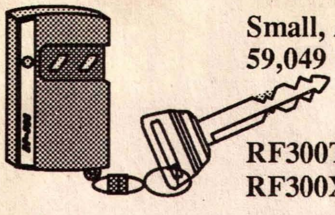

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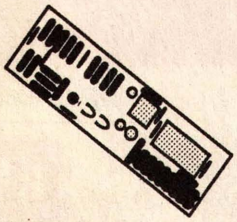

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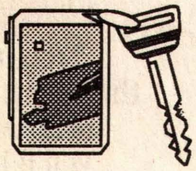

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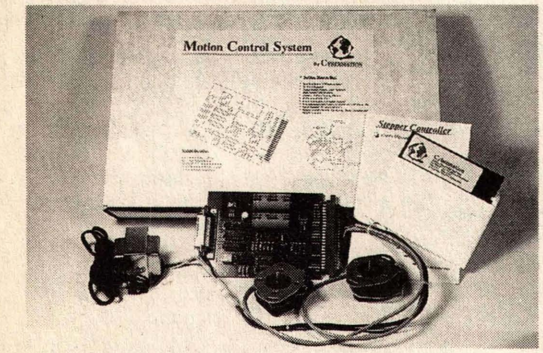

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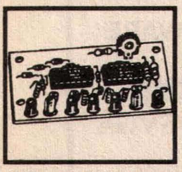

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VM-1 **$7.95**

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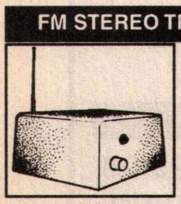

Own your own FM radio station. Any stereo signal you plug into the FMST-100 will be transmitted to any FM radio tuneable from 76 to 108MHz FM. Transmit a wireless link through an auditorium, from your car to your camper, listen to your cd's while mowing the lawn,Play music on one channel sing on the other. Clarity is excellent, aprox. 40dB stereo separation. Length of antenna determines the distance of transmission. Complete with stereo input level controls , & crystal for stereo separation. 9v battery operation

FMST-100	**$29.95**
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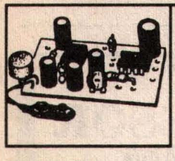

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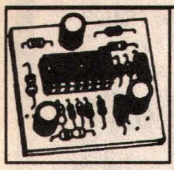
Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. SIZE: 1"x.75" 6 to 12vDC.

AA-1 **$10.95**



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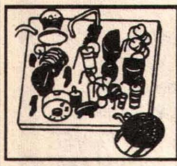
VOX-1 **$6.95**



WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-1 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM , the frequency of any broadcast FM radio. Includes a mini-electret mike. SIZE: .8"x1" 6 to 12vDC

WM-1 **$14.95**

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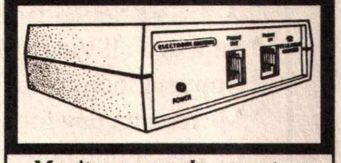

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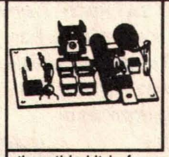

STROBE LIGHT

If you need an attention getter, warning light, or flashing light for model airplanes, then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a varible flash rate. Size 3.5"x1.8" operates on 6 or 12v DC only.

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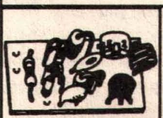

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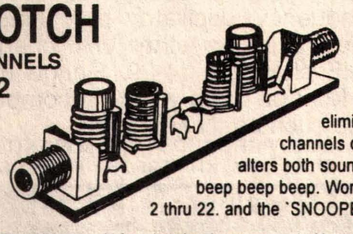

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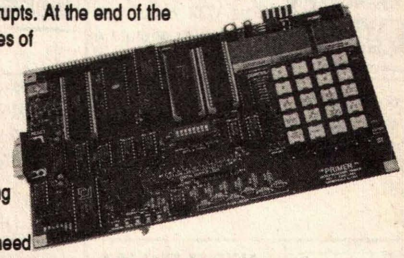

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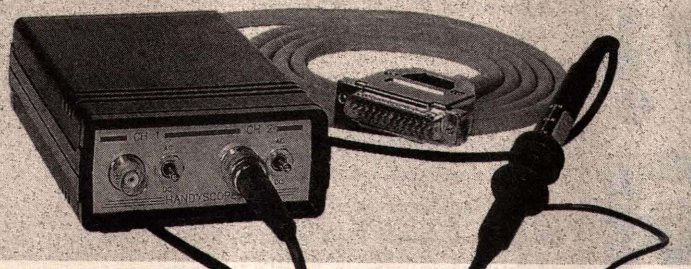

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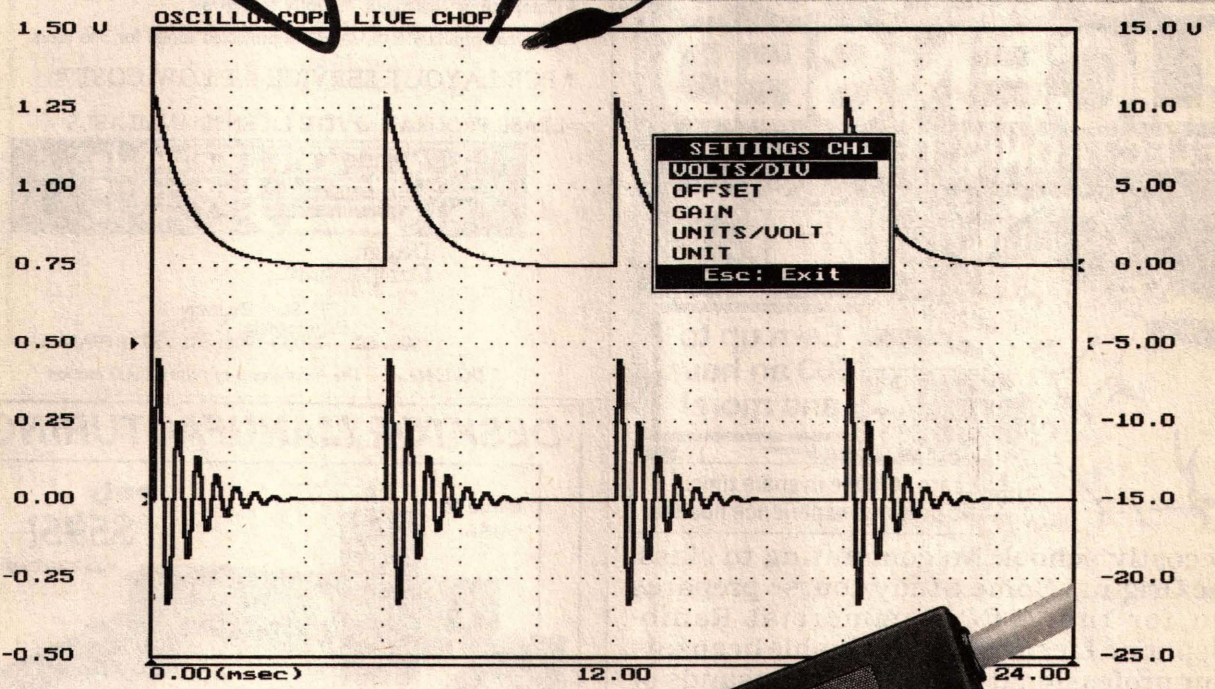
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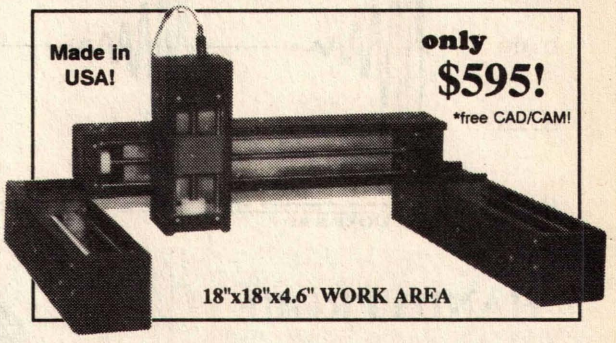

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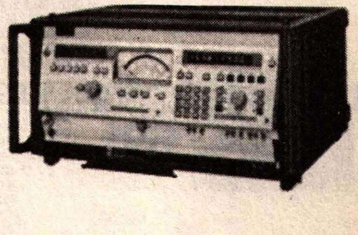

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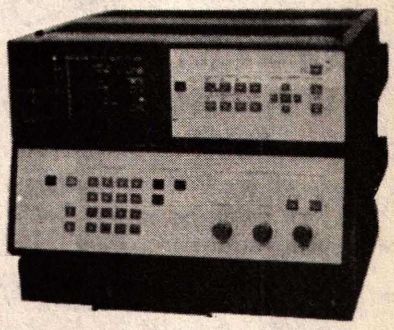

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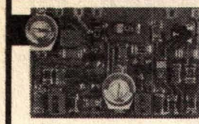

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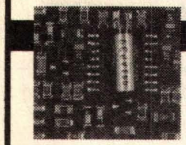

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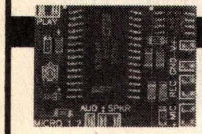

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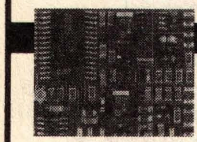

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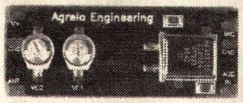

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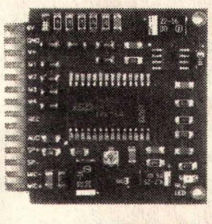

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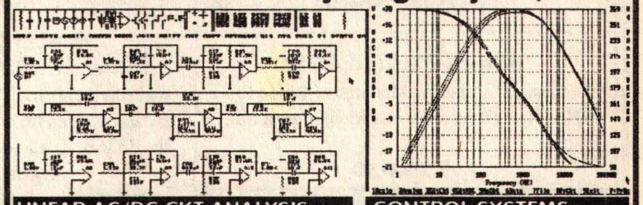

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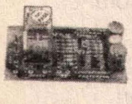

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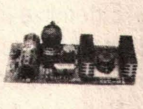

It is short circuit proof and has overload protection. Output voltage is variable over a range of 0-50 volts. Current limit trip is adjustable up to max of 3A. May use Mark V #002 transformer. (1 lb.)

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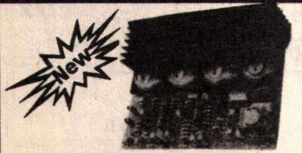
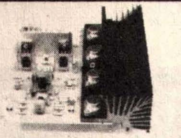
120-250W MOSFET POWER MONO AMPLIFIER AF-2 (6 lbs.) ▲▲



Power Output: 250W into 4 ohms RMS(42VX2 6A transformer is used). 120W into 4 ohms RMS(33VX2 4A transformer is used). Frequency Response: 3Hz-22,000Hz. THD: <0.03%. Signal to Noise Ratio: 91dB. Sensitivity: 1V RMS at 47k. Load Impedance: 4 or 8 ohms. Power Requirement: ±46VDC 4A or ±60VDC 6A. May use Mark V model 012 Transformer. Suggested Capacitor 10,000uf 100V Model 019. Suggested Metal Cabinet LG-1925.

Kit: $ 89.80 Asmb.$ 114.80

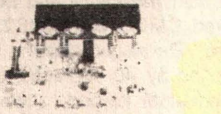
300W HIGH POWER MONO AMPLIFIER TA-3600 (5 lbs.) ▲▲▲



Power Output: 300W into 8 ohms RMS. 540W music power into 8 ohms. Frequency Response: 10Hz-20KHz. THD: < 0.05%. Sensitivity: 1V RMS at 47K. Power Requirement: 60 to 75 VDC at 8A. May use Mark V Model 007 or 009 Transformer. Suggested Capacitor: 10,000uf80-100V Model 019 Capacitor. Suggested Metal Cabinet LG-1925.

Kit 89.00
Asmb.$ 115.00

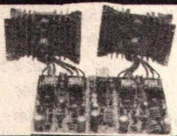
120W + 120W PRE & MAIN STEREO AMPLIFIER TA-800MK2 (4 lbs.) ▲▲



Power Output: 120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response: 10 - 20 KHZ. THD: < 0.01%. Tone Control: Bass ±12dB, Mid ±8dB, Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40V DC @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Metal Cabinet Model LG-1924.

Kit: $ 67.92 Asmb.$ 79.95

80W + 80W PURE DC STEREO MAIN POWER AMPLIFIER TA-802 (4 lbs.) ▲▲



Power Output: 80W per channel into 8 ohms. THD: < 0.05%. Frequency Response: DC to 200 KHZ, -0 dB, -3dB @ 1W. Power Requirement: 30V AC X 2 @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Capacitor 8,200uf 50V Model 017. Suggested Metal Cabinet LG-1924

Kit: $ 49.94
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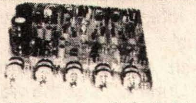
30W + 30W PRE & MAIN STEREO AMPLIFIER TA-323A (1 lb.) ▲



Power Output: 30W into 8 ohms RMS per channel. THD: < 0.1% from 100 HZ to 10 KHZ. Sensitivity: Phono 3mV @ 47K. Tuner, Tape 130mV @47K. Signal to Noise ratio: 80dB. Power Requirement: 22 to 36V AC, 3A. May use Mark V Model 002 Transformer. Suggested Cabinet LG-1684.

Kit: $ 32.50 Asmb.$ 42.50

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LG-1983	2¼X19X8"	(7 lbs.)	35.25

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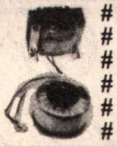

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SM-302 (11 lbs.)

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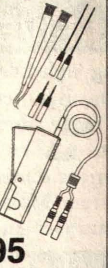

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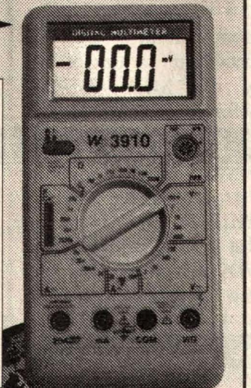

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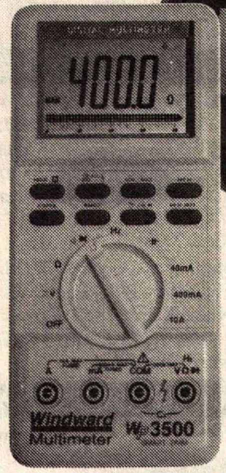

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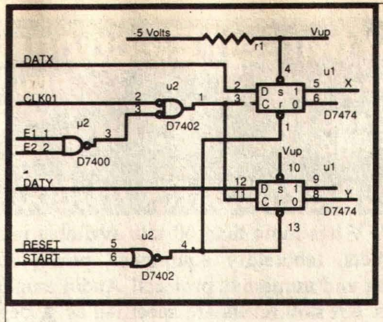

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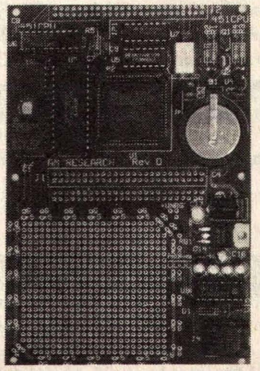

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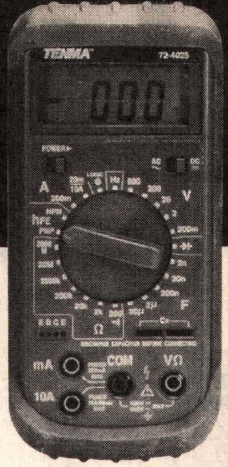

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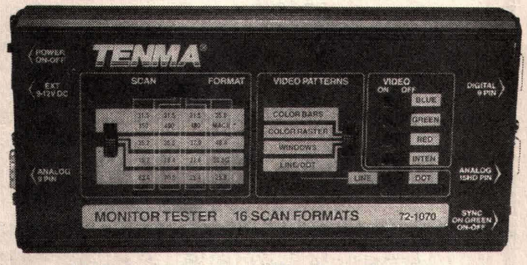

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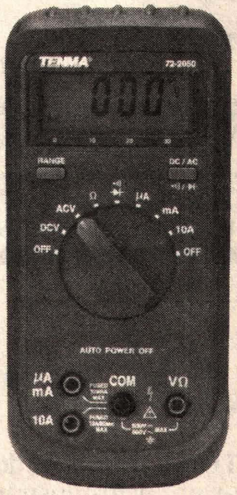

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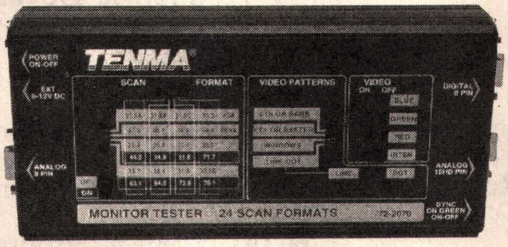

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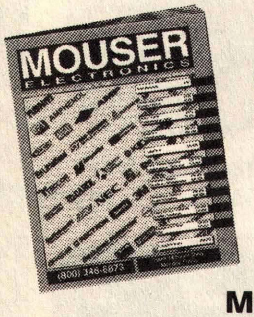

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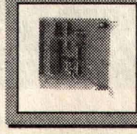

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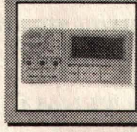

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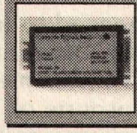

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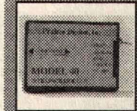

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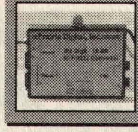

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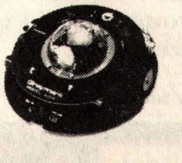

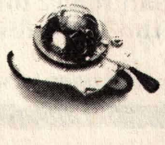

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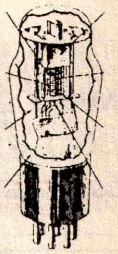

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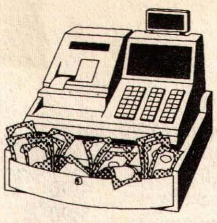

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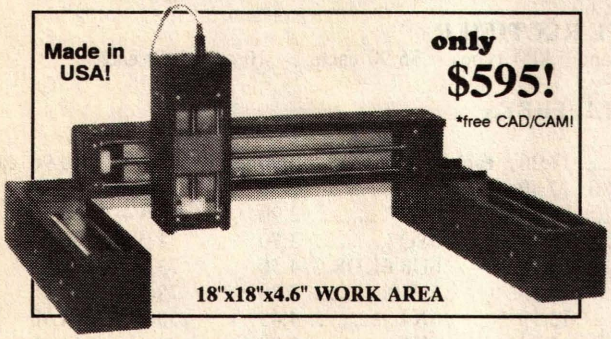

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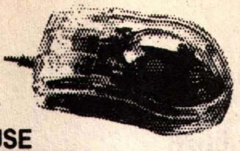
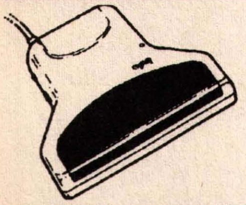


TRANSPARENT 3-BUTTON MOUSE

Watch your mouse in action! Selectable 2-or 3-button operation. Fully compatible with Mouse Systems and Microsoft. 300 DPI opto-mechanical encoder. Six-ft. cable with DB-9 connector. FCC approved. Easy-to-follow instructions and software on 5.25" floppy disk. (MUS3C) **$7.95 each**



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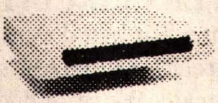
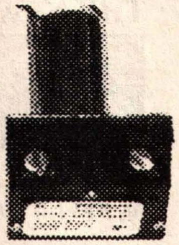


POWER CENTER

Individually lighted control switches. Lighted master on/off switch. Five heavy duty grounded power outlets controlled individually by front panel switches (Computer, Monitor, Printer, Aux1, Aux2). 15A circuit breaker. Info P/N SP-PC1. (94C006) **$24.95 each**

"AA" NICADS

Used, mixed manufacturers. (94E017)
99¢ each - 10 for $8.95



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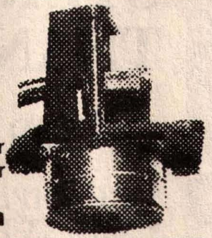
Although designed to control 120V, 20A household and industrial circuits this SPST latching relay has hundreds of other useful applications such as: controlling home functions with your computer, model railroads, yard lights, security. Control is with a 24VDC pulse through a SPDT momentary switch. Any number of switches may be paralleled to control the relay from several locations. With instructions. LCN P/N3000PL. Regular price over $20.00. (94B010) **$7.95 each**

HEATSINK

With premounted 7805 regulator and TIP 100 transistor. (94U021) **10 for $4.95**

STEPPER MOTOR ASSORTMENT

Includes various types such as unipolar, bipolar, various voltages, current ratings. (92M001) **10 for $16.95**



CARTRIDGE TAPE READ/WRITE HEAD ASSEMBLY

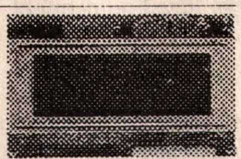
Includes stepper motor and carriage follower assembly. (94U024) **$7.95 each**

ORIX FAN

Model MU9255-21. 115 V, 50/60 Hz. Impedance protected. Ball bearings. Size 3.625" sq.x 1". (94F005) **$4.95 each**

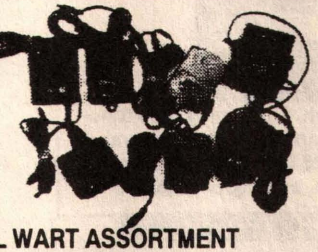
SWITCH BONANZA

Assorted switches. May include rotary, toggle, slide, "micro," breaker, pushbutton and weird. (92B012) **50 for $4.95**



LCD DISPLAY

Four lines by 20 characters. back light attached. Standard 14-pin connection. (94L010) **$14.95 each**



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A random selection of assorted voltages and current ratings. (94E004) **10 for $14.95**

ALLEGRO STEPPER MOTOR DRIVER IC

UCN5804. Single-step, two-phase and half-step modes. 1.25A rating. New. (93I002) **$4.50 each**

- Packaged with 5V stepper motor (92M010) and schematics. (93I003) **$9.95 each**

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12" Tall Teddy Bear

Talk and it imitates your voice in "bear talk." Soft and cuddly. (92T015) **$19.95 each**

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6' cable. DB-25M to Centronics 36-pin male right angle connector. (PC-6R) **$1.99 each**

KEYBOARD EXTENSION CABLE

Ten-foot cable with Din 5 male to Din 5 female connectors. (KB-10) **$1.49 each**

CABLE EXTENDER SET

Set of six-foot extender cables for VGA, mouse and keyboard for IBM and compatible computers. (94W033) **$11.75**

EXTERNAL SCSI CABLES

Dual 50-pin male Centronics connectors.

• Three feet (94W024)	**$9.95**
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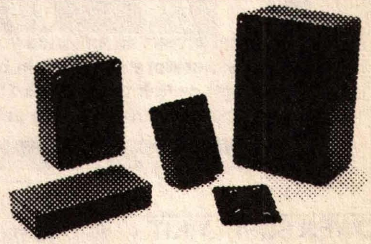
Pay radio? That's right. Part of a system that broadcast purchased programs late at night, these Codart units would turn on one of two tape recorders when a coded tone was broadcast. Contains a Z-80 with 4K of EPROM, 2K of battery backed up RAM, 18-key keyboard, 8-digit display and relays for the recorders. Reprogram it to make your own stereo or lamp timer, or a time lock to keep the kids from watching too much TV. With documentation. (92C002) **2 for $9.95**



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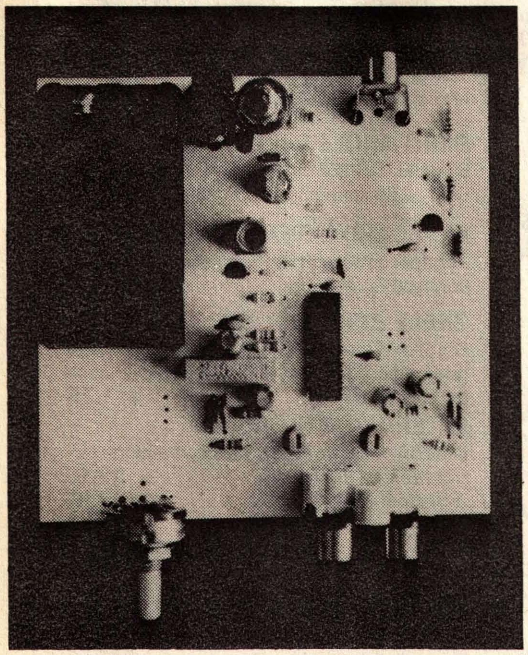

ALL NEW -- IMPROVED STEREO FM TRANSMITTER

LOADED WITH FEATURES

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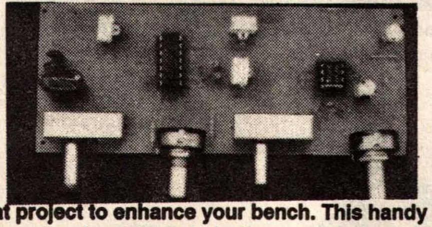
DC'S all new FM Stereo Transmitter Kit based on the unique BA1404 Stereo Broadcaster Integrated Circuit that includes all the complex circuitry to generate the stereo signal. We've added an RF amplifier circuit to provided excellent transmit range. Additional features like electronic fine tuning, voltage regulation, 38KHz multiplex crystal, input level adjustment makes the Stereocaster the top of the line Stereo FM Transmitter.

ORDER STEREOCASTER $29.95

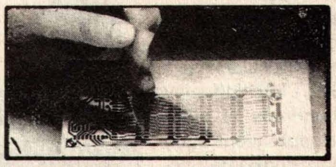
FUNCTION GENERATOR KIT ORDER FG2 KIT

$19.95



A great project to enhance your bench. This handy little function generator has a built-in buffer amplifier, a 3-decade range selector switch that covers 15 hZ to 25 khZ, output level control and function switch to select sine, square, or triangle.

MAKE CIRCUIT BOARDS THE NEW, EASY WAY



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convenient 8½ × 11 size
With Complete Instructions

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Features: Assembly language coding, assembler, disassembler, single step and multi-breakpoint program debugger, display and rewrite registers, download/upload programs from/to external systems, I/O drivers, 56-key large size keyboard, LCD display, RS-232, UART, printer interface, two expansion slots, ±5V, ±12V switching power supply, user's guide and experiment guide, Practical control applications available, such as servo and stepping motor, dot matrix display, D/A, A/D, sensors, ...

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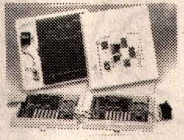

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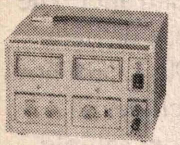
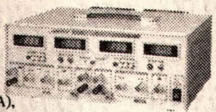
EDS-8804 $239.00 A/D and D/A converter applications for BGC-8088 or IBM PC/compatible.

EDS-8805 $479.00 Servo motor and stepper motor control for BGC-8088 or IBM PC/compatible.

DC POWER SUPPLY

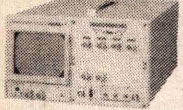


PS-303 $159.00
0-30VDC, 0-3A; 0.02%+2mV line regulation; 0.02%+3mV load regulation; 1mVrms noise & ripple; Short circuit/overload protection; constant current/voltage(CC/CV).
PS-303D $314.95 dual outputs.
PS-305 $219.95, 0-30VDC, 0-5A.
PS-305D $399.95, dual outputs, over load protection.



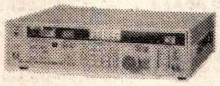
8110 $289.95
0-60VDC, 0-3A.
8112 $399.95
0-60VDC, 0-5A.
8108(8109) $549.95($699.95)
dual output, 0-60VDC, 0-3A(5A), independent tracking operation. Low ripple.
8102(8103) $399.95($489.95) dual 0-30VDC/0-3A(5A), fixed 5VDC/3A, indepedent tracking operation, constant voltage and current. Slave/Master, Serial/Parallel connection.
PS-1610S(8107) $289.00($399.95) 0-16VDC, 0-10A.
PS-2243(2245) $139.00($159.00) 0-12/0-24VDC,3A(5A).
8200(8201) $179.95($239.95) 0-30VDC(digital meter), 0-3A(5A).
8202(8203) $499.95($549.95) 3 outputs, digital display, dual 0-30VDC/0-3A(5A), a fixed 5VDC/3A, indepedent tracking operation, constant voltage and current.

AM/FM SWEEMAR SCOPE



SM-6225B/C $1999.95
Freq Range: (AM)490KHz; (FM) 10-11.4MHz; *Acuracy*: ± 0.1%
Marker: (AM)455KHz, ±5KHz, ±10KHz; (FM)10.7MHz, ±7.5KHz, ±150KHz.

AM/FM STD SIGNAL GEN.

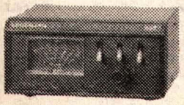


SG-4110A $1799.00
Freq: 100KHz-110MHz
Display: 6-digit LED
Accuracy:
<±(5x10-E5 ±1 count)
Resolution:100Hz (100-34.99MHz); 1KHz (35MHz-110MHz).
Output Range: -19dBu, -99dBu, 1dB step
Impedence: 50 Ohm VSWR 1.2.

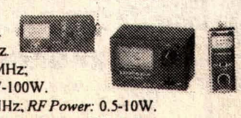
TV COLOR PATTERN GEN.

CPG-1366A $159.95
VHF NTSC;
Freq.: 45.75, 175.25, 187.25 Mhz;
RF Output: 10mV.
Impedence: 75 Ohm;
Video Output: BNC, 1Vp-p

SWR/RF POWER METER

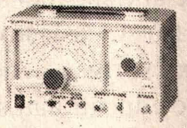


310 $89.95
Freq.Range: 1.8-150MHz.
RF Power: 0-4W/20W/200W
SWR Measure.: 1.0 - ∞, 4W min.
Accurcy: 5%-10%; SO-239 plugs.
Insertion Loss: O.3dB.
Input/Output Imp.: 50Ω.



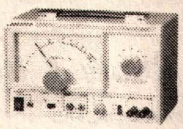
320 $89.95, 130-520MHz.
330 $119.95, 1.8-520MHz.
SWR-3P $26.95 1.7-150MHz;
RF Power: 0.5-10W, 0.5W-100W.
SWR-2P $22.95, 1.7-30MHz; *RF Power*: 0.5-10W.
PM-330 $136.00 1.8-500MHz; 0-5W/20W/120W.

RF SIGNAL GENERATOR



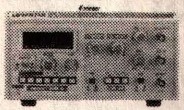
SG-4160B $119.00
100KHz-150MHz up to 450MHz on 3rd harmonics; 6 ranges; AM modulation. *RF Output*: 100mVrms to 3-5MHz. *Modulation*: Int. 1KHz AM, Ext. 50Hz-20KHz AM.
Audio Output: 1KHz, 1Vrms.
SG-4162AD $229.95, with Freq. Counter 1Hz-150MHz, 6 digits, for internal & external signals.

AUDIO GENERATOR



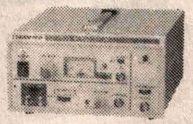
AG-2601A $119.00
10Hz-1MHz, 5 ranges;
Output Level: sinewave 0-8Vrms, square 10Vp-p.
Output Impedence: 600 Ohm.
Distortion: <0.05% 500Hz-50KHz; <0.5% 50KHz-500KHz.
AG-2603AD $229.95, with Freq. Counter 1Hz-150MHz, 6 digits, for internal & external signals.

FUNCTION GENERATOR



FG-2100A $169.95
0.2Hz-2MHz in 7 ranges; Sine, Square, Triangle, Pulse & Ramp
Output: 5mVp-p-20Vp-p, 1% distortion.
VCF: 0-10V control freq. to 1000:1.
FG-2102AD $229.95 generates signals same as FG-2100; 4-digit counter display, TTL & CMOS outputs, 30ppm ±1 count accuracy.
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
(FG)2103 $329.95, Digital sweep generator, 0.5Hz-5MHz in 7 ranges. *Operating Mode*: sweep, AM, gated burst, VCG.
Freq. Counter: Int. 0.5Hz-5MHz; Ext. 5HZ-10MHz

FM STEREO MODULATOR



AG-2011A $549.00
RF SECTION:
Carrier: 98MHz ±2MHz;
Output: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
Pilot: 19KHz ±2Hz, 0.8Vrms
INT. MODULATION: 400KHz, 1KHz ±1%, 1Vrms, distortion < .5%; *L-R Seperation*: >50dB.
EXT. MODULATION: *Freq.*: 50Hz-15KHz
L-R Seperation: >45dB 100Hz-3KHz; >35dB 50Hz-15KHz..

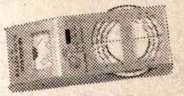
AC MILLIVOLT METER

MV-3100A $159.95 wide band 5Hz~1MHz; 3 scales, mV, dB, &dBm; 300μV~100V in 12 ranges, 10μV resolution; -70~40dB in 12 ranges, 0dB=1Vrms, 0dBm=0.755V); ±3% accuracy; Input impedence 10MΩ; Noise <2%.
MV-3201B $309.95 dual channels, simultaneous measurement..

OSCILLOSCOPE

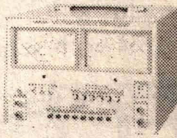
OS-7305B $249.00 DC~7MHz; *Vertical*: 10mV/Div; Horizontal: 250mV/Div; 10Hz~100KHz in 4 ranges; 3" CRT;Internal and External Sync.; Input: 1MΩ/35pF.
OS-7010A $369.00 DC~10MHz. 5" CRT,
OS-7001A $369.00 Aligment Scope. DC~200KHz, 5" CRT.

GRID DIP METER



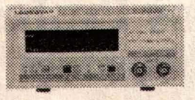
DM-4061A $89.95 1.5-250MHz, 6 bands;6 plug-in coils, 2 transistor, and 1 diode.
Modulation: ≈ 2KHz Sinewave. *Crystal Oscillator*: 1-15MHz.
Wave absortion meter. Using 9VDCpower supply.

AUTO DISTORTION METER

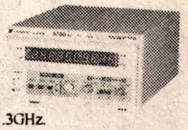


DM-3104A $799.95
MEASUREMENT:
Range: 0.01%-30%, 0.1/0.3/1/3/10/30% full scale.
Freq.: 400Hz±10%, 1000Hz±10%(HPF).
Input: 3mV-100V, ratio measuring 20dB.
Auto. Switching Ranges: Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
DM-3204 $1,599.00 dual channels.

FREQUENCY COUNTER

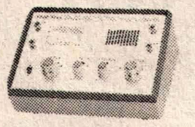


FC-5250C $119.95
Freq. Range: 10Hz-220MHz: (HF)10Hz-20MHz, (VHF)10MHz-200MHz
Gate Time: 0.1 & 1sec.
Max. Input: 10Vp-p.
Input Sensitivity: 35mV 10Hz-200MHz.
Input Imped.: (HF) 1MOhm, (VHF) 50Ohm.



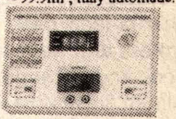
FC-5260A $146.00
10Hz-600MHz.
FC-5270A $149.95
10Hz-1300MHz.
FC-5600B $321.00
10Hz-600MHz.
(FC)5700B $329.95 10Hz ~ 1.3GHz.

SIGNAL TRACER/INJECTOR



SE-6100 $134.95
TRACER: Gain Max. 60dB
Attenuation: 0/20/40/60dB
Input Imped.: 100KOhm
Output Imped.: 600Ohm;
Speaker: 8 Ohm.
INJECTOR: *Freq.*: 1KHz Squarewave; *Output Level*: Continuously variable 0 - 4.5Vp-p.

AUTO. CAPACITANCE METER



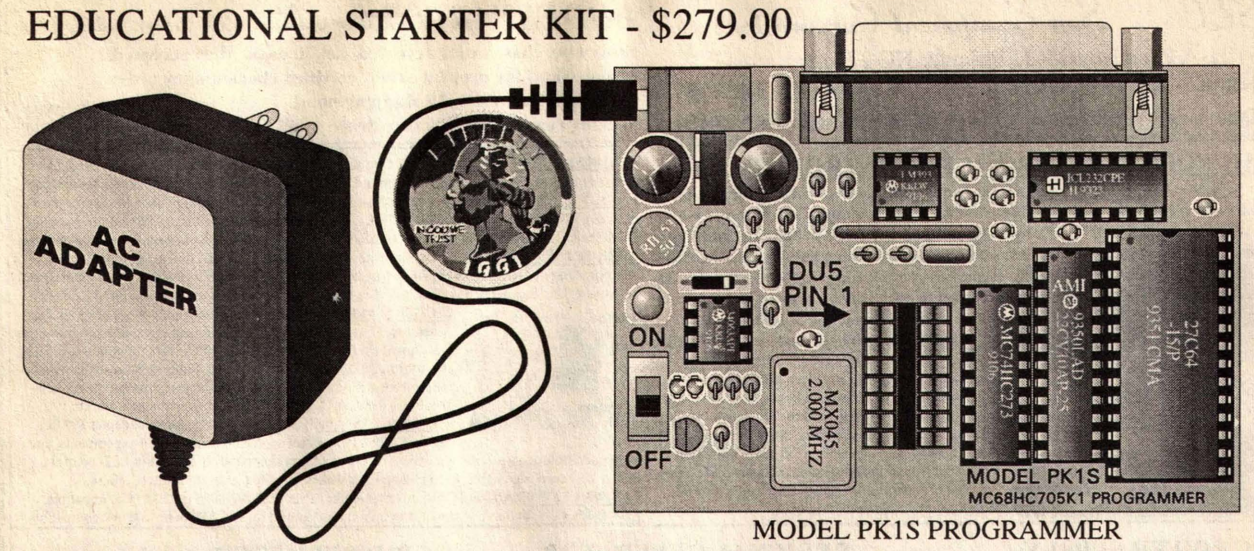
CM3300A $139.00 10 ranges, 99.9pF ~ 99.9mF, fully automatic.
Resolution: 0.1pF lowest, 0.1% full scale.
Accuracy:
0.5% of full scale±1digit to 99.9μF,
1% of full scale±1digit to 99.9μF.
Display: 3 digit LED.
Unit indicator: pF, nF, μF, mF. Overrange indicator.

WOW-FLUTTER METER

WF-3103 $699.95
Freq. Range: 3KHz±10% JIS/CCIR; 3.15KHz±10% DIN.
Range: 0.03/.1/.3/3% full scale.
Accuracy: ±5%.
WF-3105A $799.95, digital;
Function: LIN/WOW/Flutter/WTD.
Freq Cntr: 10Hz-9.99MHz.
Indication: CCIR/DIN/JIS.

CIRCLE 334 ON FREE INFORMATION CARD

MC68HC705K1 MICROCONTROLLER PROGRAMMER - $149.00
EDUCATIONAL STARTER KIT - $279.00



MODEL PK1S PROGRAMMER

Motorola's MC68HC705K1 is a marvelously flexible and inexpensive 16 pin microcontroller. The PK1S connects to a PC serial port and provides the fastest, easiest way to program these devices. The PK1S programmer, power supply, host PC control software and manual is $149.00. Learn how to use microcontrollers in embedded systems with the educational starter kit which includes the above plus a PC based cross assembler, Motorola technical specs and applications guide, sample programs with schematic diagrams and an erasable K1 chip for $279.00.

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- Removable, reversible tool pallet
- Case bottom consists of six adjustable compartments
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- 2 keyed locking latches
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- Reinforced steel corner braces
- Size 18" x 6 1/4" x 13"

(Tools Not Included)

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NEURAL LAB 'C' LIBRARY	**$29.99**
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TEK 7603 100 MHz 3-slot frame	**$250.00**
TEK 7A13 100 MHz Differential Comparator	**$450.00**
TEK 7A22 1 MHz High CMRR Differential Amp	**$400.00**
TEK 7B53A 100 MHz Dual Time Base	**$200.00**
TEK SC502 15 MHz Dual Trace O'scope, TM500	**$375.00**
TEK 7904 500 MHz 4-slot frame	**$500.00**
TEK 7904 . System w/7A24,7A26,7B80,7B85	**$1,200.00**
TEK 7A24 400 MHz Dual Trace Amplifier	**$450.00**
TEK 7A26 200 MHz Dual Trace Amplifier	**$250.00**
TEK 7B10 1 GHz Time Base	**$500.00**
TEK 7B15 1 GHz Delaying Time Base	**$600.00**
TEK 7B80 400 MHz Delayed Time Base	**$200.00**
TEK 7B85 400 MHz Delta Delaying Time Base	**$250.00**
TEK 7B87 400 MHz Time Base,pretrigger clk	**$250.00**
TEK 7S14 1 GHz Dual Channel Sampling Unit	**$700.00**
TEK P6007-opt.01 100X 20 MHz 1.5kV Probe, NEW	**$75.00**
TEK P6046 100 MHz 1X/10X Diff. Probe	**$750.00**
TEK P6202A 500 MHz 10X FET Probe	**$275.00**

WAVEFORM GENERATORS

HP 3310A 5 MHz Function Generator	**$325.00**
HP 3312A 13 MHz Function Generator	**$800.00**
HP 8111A 20 MHz Pulse/Function Generator	**$1,500.00**
TEK DD501 Digital Delay Generator	**$375.00**
TEK FG502 11 MHz Function Generator	**$325.00**
WAVETEK 132 2 MHz VCG / Function / Noise Gen	**$600.00**
WAVETEK 164 30 MHz Sweep/Function Generator	**$850.00**
HP 214B 10 MHz Pulse Gen., 50V / 50 ohms	**$2,250.00**
HP 8015A-opt002 50 MHz Dual Output Pulse Gen.	**$700.00**
HP 8080A 1 GHz Dual Channel Pulse Gen.	**$1,400.00**
HP 8082A 250 MHz Pulse Generator	**$1,400.00**
TEK PG502 250 MHz Pulse Generator, Tr<1nS	**$700.00**
HP 8165A Prog. Signal Source,1 mHz-50 MHz	**$2,600.00**
TEK AWG5105 Arbitrary Waveform Generator	**$3,000.00**
TEK PFG5505 Prog. 12 MHz Pulse/Function Gen.	**$1,275.00**

VOLTAGE & CURRENT

HOLT 11 AC Thermal Converter Set	**$5,250.00**
KEITHLEY 228 Prog. Voltage/Current Source	**$2,250.00**
HP 6177C DC Current Source, to 50V,500mA	**$600.00**
HP 6181C DC Current Source, 100 V, 250 mA	**$675.00**
HP 6186C DC Current Source, to 300V,100mA	**$750.00**
KEITHLEY 220 Programmable Current Source	**$2,000.00**
KEITHLEY 225 Current Source, 1 nA-99.9 mA	**$450.00**

IMPEDANCE & COMPONENT TEST

HP 4800A Vector Impedance Meter	**$550.00**
BOONTON 62AD 1 MHz Ind. Meter, 2-2000 uH	**$700.00**
BOONTON 72BD 1 MHz Cap. Meter, 2-2000 pF	**$700.00**
HP 4342A Q-Meter, 70 kHz-22 MHz, Q=5-1000	**$2,250.00**
MEGURO MQ-171 VHF Q Meter, 20-230 MHz	**$1,100.00**
E.S.I. RS925 9-Decade Resistance Standard	**$2,000.00**
E.S.I. SR1010 Resistance Transfer Standards	**$800.00**
FLUKE 5450A Programmable Resistance Standard	**$2,750.00**
GR 1409 Standard Mica Capacitors, 0.05%	**$150.00**
GR 1432-N 5-Decade Resistor, 0.1 OHM-11K	**$275.00**
GR 1432-U 4-Decade Resistor,0.01-111.1 ohm	**$175.00**
GR 1433-X 6-Decade Resistor, 0.1 OHM-111K	**$550.00**
HP 16470B Stable Inductor Set (4)	**$500.00**
ROD-L M500AV 5000 Volt AC HIPOT Tester	**$700.00**
TEK 576 Curve Tracer, to 220W	**$2,350.00**
TEK 577D1/177 Storage Curve Tracer	**$2,250.00**
TEK 577D2/177 Curve Tracer, to 100W	**$1,750.00**
TEK 7CT1N Curve Tracer, to 0.5W	**$500.00**

POWER SUPPLIES

GLASSMAN PS/EG-05R-06 5 kV Power Supply, to 6mA	**$500.00**
HP 6002A-opt.01 50V/10A Power Supply, to 200 W	**$875.00**
HP 6207B 160V at 200mA CV/CC Power Supply	$300.00
HP 6209B 320V at 100mA CV/CC Power Supply	$300.00
HP 6261B-027 20V at 50A CV/CC Power Supply	$675.00
HP 6264B 20V at 20A CV/CC Power Supply	$500.00
HP 6296A 60V at 3A CV/CC Power Supply	$400.00
HP 6438B 60V at 5A CV/CC Power Supply	$375.00
HP 6255A 40V 1.5A Dual Output Supply	$500.00
TEK PS503A Dual Power Supply	$250.00
ACME PS2L-1000 0-75 V/ 0-150 A/ 1000 Watt Load	$450.00
HP 59501A HPIB Power Supply Programmer	$175.00
HP 6827A Bipolar Supply/Amp, 100 V 500 mA	$800.00
KEPCO BOP 1000M Bipolar Op Amp/Supply, 1 kV 40mA	$600.00

TIME & FREQUENCY

HP 5315A 100 MHz/100 nS Universal Counter	$550.00
HP 5316A 100 MHz/100 nS Univ. Count, HPIB	$750.00
HP 5316A-001 100 MHz/100 nS Univ., HPIB, TCXO	$850.00
HP 5334A-030 100 MHz Statistical & 1.3 GHz	$1,500.00
HP 5370B-001 Time Interval Counter, to 20 pS	$2,250.00
HP E1420A-10,30 VXI Counter, 200 MHz & 2.5 GHz	$1,500.00
TEK 7D15 225 MHz Universal Counter/Timer	$275.00
TEK DC5009 Programmable 135 MHz Count/Timer	$750.00
TEK DC503A 125 MHz Universal Counter/Timer	$500.00
TEK DC509 135 MHz High Resolution Counter	$700.00
HP 5340A 18 GHz Frequency Counter	$1,400.00
HP 5340A-01,11 18 GHz Counter, OCXO, HPIB	$1,900.00
GR 1115C Crystal Frequency Standard	$1,600.00

AUDIO & BASEBAND

HP 3580A-002 Spectrum Analyzer, 5 Hz-50 kHz	$1,850.00
HP 3586C Selective Level Meter	$1,750.00
HP 339A Distortion Analyzer, -95 dB THD	$2,400.00
TEK DA4084 Distortion Analyzer, 0.0025% THD	$1,500.00
HP 3400A RMS Voltmeter, 10 Hz-10 MHz	$250.00
HP 3335A Synth./Level Gen., 200 Hz-80 MHz	$3,250.00
P.A.R. 189 Filter/Amplifier, 0.1 Hz-110 kHz	$350.00
ROCKLAND 752A-opt.02 Dual Low Pass Filter, 115 dB/oct	$1,100.00
TEK AM502 Differential Amplifier	$575.00

RF & MICROWAVE

HP 5371A Modulation Domain Analyzer	$5,900.00
HP 8406A Comb Gen.,1/10/100 MHz increment	$450.00
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HP 8444A-opt059 Tracking Generator, 0.5-1500 MHz	$1,500.00
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HP 85021A Directional Bridge, 0.01-18 GHz	$1,200.00
HP 8505A/8503A Network Analyzer, 0.5-1300 MHz	$6,000.00
NARDA 7000A Microwave Multimeter, 0.1-18 GHz	$1,950.00
WILTRON 560A/-98K50 Scalar Analyzer w/40 GHz bridge	$3,000.00
BOONTON 1020 Synth. Sig. Gen., 0.15-540 MHz	$1,850.00
BOONTON 102C Signal Generator, 0.45-520 MHz	$850.00
GIGATRONICS 875/86 Levelled Multiplier, Ka & V band	$8,000.00
HP 85100V Freq. Multiplier, 50-75 GHz out	$4,250.00
HP 8654B Signal Generator, 10-520 MHz	$750.00
HP 8660C Synthesizer, w/86603A &86633B	$4,250.00
WILTRON 6742A-opt.01 Synth. Sig./Swp. Gen., 18-40 GHz	$9,000.00
EIP 928-opt.9201 Programmable Sweep Gen.,1-18 GHz	$4,000.00
HP 8620C Sweep Oscillator Frame	$550.00
HP 8620C-opt011 Sweep Oscillator Frame, HPIB	**$675.00**
HP 86222A RF Plug-In, 10-2400 MHz	**$1,400.00**
HP 86222B-opt.2 RF Plug-in, 10-2400 MHz, atten.	**$1,750.00**
HP 86240A RF Plug-in, 2.0-8.4 GHz	**$1,000.00**
WAVETEK 1067 Sweep Gen., 1-400 MHz, 75 Ohms	**$500.00**
BOONTON 42B/41-4B Power Meter, 1 MHz-12.4 GHz	**$475.00**
BOONTON 42B/41-4E Power Meter, 1 MHz-18 GHz	**$650.00**
BOONTON 42B/42-S/3 Power Meter, 1 MHz-8 GHz	**$375.00**
HP 11683A Power Meter Range Calibrator	**$750.00**
HP 432A/478A Power Meter, 0.01-10 GHz	**$375.00**
HP 435A/8481A Power Meter, 10 MHz-18 GHz	**$1,000.00**
HP 435A/8482A Power Meter, 0.1-4200 MHz, 100mW	**$1,000.00**
HP 435A/8482H Power Meter, 0.1-4200 MHz, 3 W	**$1,150.00**
HP K486A WR42 Thermistor Mount, 18-26.5 G	**$400.00**
HP Q8486A WR22 Power Sensor, 33.0-50.0 GHz	**$1,500.00**
WAVETEK 1034A Portable Power Meter,0.001-18GHz	**$375.00**
BOONTON 82AD Modulation Meter, 10-1300 MHz	**$1,000.00**
ENI 503L Amplifier, 3 Watts, 2-510 MHz	**$850.00**
ENI 600L Amplifier, 150 mW, 0.8-1020 MHz	**$450.00**
M.S.C. MC5112 Noise Source, 25.5 dB, 1-12 GHz	**$325.00**
PANASONIC VP-8125A FM Stereo Signal Generator	**$850.00**

COAXIAL & WAVEGUIDE

DEMORNAY DBE-675-10 WR42 Directional Coupler, 10 dB	**$350.00**
HP 11691D Dir. Coupler, 22 dB, 2-18 GHz	**$500.00**
HP 11692D Dual Dir. Coupler,22 dB,2-18 GHz	**$900.00**
HP 778D-opt.011 Dual Dir. Coupler,20 dB,0.1-2GHz	**$400.00**
HP 779D Dir. Coupler,20 dB, 1.7-12.4 GHz	**$375.00**
HP 8472A Crystal Detector, 10 MHz-18 GHz	**$150.00**
HP R532A Frequency Meter, 26.5-40.0 GHz	**$500.00**
MILITARY AS-1346B Double Ridge Horn, 3-8 GHz, N(f)	**$75.00**
NARDA 26298 20 dB Atten., 150 W, DC-1 GHz	**$175.00**
NARDA 3000-SERIES Directional Couplers	**$150.00**
NARDA 3090-SERIES Precision Hi Directivity Coupler	**$225.00**
NARDA 4000-SERIES SMA Mini Directional Couplers	**$75.00**
NARDA 4203-6 Dir. Coupler, 6 dB, 2-18 GHz,SMA	**$225.00**
NARDA 4700 Step Atten., 0-9 dB, DC-12.4 GHz	**$175.00**
NARDA 5070-SERIES Precision Reflectometer Couplers	**$300.00**
PRD 312AF1 WR28 E-H Plane Tuner, 26.5-40 GHz	**$350.00**
TRG A510 WR28 Precision Atten., 0-50 dB	**$1,000.00**
WEINSCHEL 1515 Power Divider, DC-18 GHz, SMA	**$125.00**
WEINSCHEL 1579 Power Divider, DC-26.5 GHz, 3mm	**$275.00**
WILTRON 97SF50-1 Directional Bridge, 0.01-18 GHz	**$1,500.00**

MISCELLANEOUS

HP 28687A LAN Wire Test Instrument	**$750.00**
HP 4935A Transmission Test Set	**$1,650.00**
HP 59401A HPIB Bus Analyzer	**$700.00**
TEK 1411R-opt.04 PAL Test Signal Generator	**$2,750.00**
TEK 144 NTSC Test Signal Generator	**$700.00**
TEK 147A NTSC Test Signal Generator	**$950.00**
TEK 1485R Waveform Monitor, NTSC & PAL	**$1,850.00**
TEK 521A PAL Vectorscope	**$1,500.00**
TEK J16/J6523 Spot Luminance Photometer	**$900.00**
HP 37204A-opt.2 2 port Fiber-Optic HPIB Extender	**$600.00**
HP 59307A HPIB VHF Switch	**$200.00**
P.A.R. 5206 Lock-In Amplifier, 2 Hz-200 kHz	**$3,000.00**

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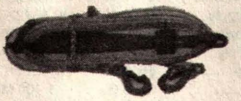
30-300 MHZ RECEIVER

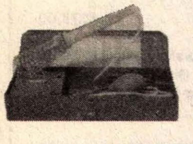
R-1283/GRC RECEIVER covers VHF in bands 30-90 and 90-300 MHz AM-FM-CW-Pulse continuously tunable; 21.4 MHz IF. Selectable bandwidths 67 or 300 KHz and 3 MHz. Solid-state; with tuning and level meters, BFO, AGC, video output and N connections. Requires 115 V 60 Hz; 3.5x19x17, 30 lbs sh. **Used-reparable** **$145.00**

GUY WIRE ASSEMBLY



50 foot 3/16" steel braid wire with two heavy-duty snap hooks on 17" long steel bracket with locking pulley and tension adjust. Designed for military antenna, but suitable for other wire support uses; 8lbs sh. **#SMD-423629, UNUSED $19.95**

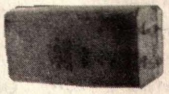
SOLDERING KIT



WELLER SOLDER/DESOLDER STATION with TCP-24G 48 W pencil iron, eight solder tips from 3/64" to 1/8" wide, 600° or 700°F; six desolder tips with orifices .038" to .090"; and 2.5"Hx13"Wx4"D steel carrying case. Requires 115 VAC 60 Hz; 7 lbs sh.

WELLER #WTCPK, UNUSED.......................... **$69.50**

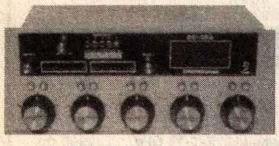
ENERGY STORAGE CAPACITORS



Removed from equipment; each 10x4.5x3.5, 10 lbs sh.

32 MF 4500 VDC	**$36.00**
88 MF 1200 VDC	**$17.50**
224 MF 1500 VDC	**$27.00**

RAMKO AUDIO MIXER



RAMKO DC-5RA 5-INPUT AMP/MIXER, each input has Level Control and can be connected to "A" or "B" buss or not connected to either. Each buss has LED VU-meter and Master gain control. Input level -60 DBM 510 ohms/0 DB 560K ohms. Response 20 Hz-20 KHz. Speaker monitors input channel; with manual copy. Requires 115 VAC 60 Hz; 7x19x15, 17 lbs sh. **USED-EXCELLENT,** not tested **$99.50**

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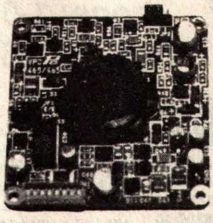
Sees an entire room through an 1/8" hole



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Educational Kits for the Serious Hobbyist

Caller Block

Connects between your telephone and its wall jack, and prevents the phone from ringing unless the calling party is one which you've entered into memory using your touch-tone phone. Your answering machine can handle all other calls. Change between two separate directories of callers with a simple flip of a switch.

Telephone Caller ID

Connects to telephone wall jack. Shows the telephone number of the calling party along with the time of day the call was received, on a 16x1 character LCD display. Stores the info from the last five calls in memory. Complete stand alone, no computer interface needed.

Telephone Call Restrictor

Connects to telephone wall jack. Disables all phones on the line if attempting to either: dial a number that has been stored in memory "Block Mode" or, dial a number that has not been stored in memory "Allow Mode". Use touch-tone phone to enter telephone numbers into memory, and choose mode. Program from any phone on the line using your password.

50 MHz Frequency Counter

Reads frequency from 1Hz to 50MHz and displays it on a 16x1 character LCD display. Auto-range feature provides floating decimal point and automatically affixes the correct suffix (Hz, KHz, or MHz). Microcontroller based, very few additional components.

Telephone Scrambler

Scrambles your voice before sending it over the telephone line, and descrambles it on the other end. Connects between your telephone and wall jack. No modifications are required to your telephone. Full duplex operation.

Electronic Message Module

Use a set of four pushbutton switches to write and store your own personal message in a 8-pin non-volatile EEPROM, which can then be printed across a 16x1 LCD display. Message can be up to 240 characters long. EEPROM can be removed from socket and still retain message. Re-program over and over with new messages.

Vocal Filter

An audio device which can be used with a home component stereo system, to filter out the main vocal sound track from standard stereo recordings (CD, tape, record or FM), leaving the background music to sing along with. Produce your own karaoke tapes.

Vocal/Effects Mixer

An audio device which hooks up to the "tape monitor" jacks of any home component stereo, and allows you to mix your own voice with the program source (CD, tape, record, FM, etc.) as its being played through your stereo. Features Bass, Treble, and Reverb controls for your voice. Great for having your own karaoke party.

ACCORD ELECTRONIC SYSTEMS, INC.

CAPACITORS

QTY	1	100	1000
RAD. LYTIC 25VDC			
1µF	.05	.040	.035
2.2µF	.05	.040	.035
3.3µF	.05	.040	.035
4.7µF	.05	.040	.035
6.8µF	.05	.040	.035
10µF	.05	.045	.04
22µF	.05	.045	.04
33µF	.06	.055	.05
47µF	.06	.055	.05
100µF	.08	.07	.05
220µF	.08	.07	.055
330µF	.09	.08	.06
470µF	.10	.09	.08
1000µF	.22	.20	.17
2200µF	.42	.40	.38
3300µF	.53	.50	.47
4700µF	.91	.87	.83
RAD. MONO 50V			
.001µF	.05	.045	.035
.0022µF	.05	.045	.035
.0047µF	.05	.045	.035
.01µF	.05	.045	.035
.022µF	.05	.045	.035
.047µF	.05	.045	.035
.1µF	.05	.045	.035
.22µF	.25	.22	.18
.47µF	.42	.35	.28
CERAMIC 50V			
5pF	.05	.038	.025
10pF	.05	.038	.025
18pF	.05	.038	.025
22pF	.05	.035	.025
27pF	.05	.038	.025
33pF	.05	.038	.025
47pF	.05	.038	.025
68pF	.05	.038	.025
82pF	.05	.038	.025
100pF	.05	.038	.025
120pF	.05	.038	.025
150pF	.05	.038	.025
180pF	.05	.038	.025
220pF	.05	.038	.025
270pF	.05	.038	.025
330pF	.05	.038	.025
470pF	.05	.038	.025
1000pF	.05	.038	.025
2200pF	.05	.038	.025
3300pF	.05	.038	.025
4700pF	.05	.038	.025
.01µF	.05	.038	.025
.022µF	.05	.04	.03
.047µF	.07	.055	.035
.1µF	.07	.058	.04
DIP TANT. 25VDC			
1µF	.14	.11	.08
2.2µF	.14	.11	.08
4.7µF	.23	.185	.14
10µF	.28	.26	.22
22µF	.34	.27	.24
47µF	1.22	1.07	.94
AXIAL LYTIC 25VDC			
4.7µF	.09	.075	.054
10µF	.10	.08	.06
22µF	.14	.115	.084
47µF	.16	.13	.096
100µF	.19	.15	.11
220µF	.27	.215	.16
470µF	.35	.28	.31
1000µF	.45	.36	.27
2200µF	.89	.715	.54

DIODES

QTY	1	100	1000
1 AMP RECTIFIER			
1N4001	.03	.02	.015
1N4004	.04	.025	.019
1N4007	.05	.035	.022
3 AMP RECTIFIER			
1N5401	.06	.05	.042
1N5404	.07	.055	.045
1N5408	.08	.06	.049
6 AMP RECTIFIER			
6A10	.21	.185	.156
6A100	.32	.29	.25
1 AMP SCHOTTKY			
1N5817	.20	.145	.09
1N5818	.23	.165	.10
1N5819	.25	.18	.11
3 AMP SCHOTTKY			
1N5820	.34	.255	.17
1N5821	.38	.285	.19
1N5822	.42	.315	.21
GERMANIUM			
1N34A	.10	.08	.06
1N60	.10	.08	.06
1N270	.17	.15	.13
SWITCHING			
1N914	.035	.025	.015
1N4148	.025	.02	.01
1N4448	.035	.025	.015
1 W ZENER			
1N4728	.06	.054	.047
through			
1N4764	.06	.054	.047

INTEGRATED CIRCUITS

QTY	1	100	1000
PART #			
TIL111	.38	.34	.31
MC1458	.43	.36	.29
LM1488	.47	.43	.39
LM1489	.47	.43	.39
CD4001	.29	.25	.21
CD4011	.29	.25	.21
CD4013	.37	.33	.29
CD4017	.37	.33	.29
CD4025	.37	.33	.29
CD4028	.37	.33	.29
CD4040	.47	.43	.39
CD4049	.37	.33	.29
CD4051	.44	.40	.36
CD4066	.38	.34	.31
CD4069	.37	.33	.29
CD4093	.37	.33	.29
MOC3011	.40	.36	.32
LM311	.37	.33	.29
LM324	.47	.36	.25
LM339	.48	.37	.27
LM358	.48	.37	.27
LM386	.67	.49	.33
LM393	.37	.33	.29
4N25	.54	.39	.28
4N28	.58	.41	.34
LM555	.43	.38	.33
LM556	.47	.42	.38
LM741	.43	.38	.33
74LS244	.40	.36	.32
74LS245	.37	.33	.29
74LS374	.37	.33	.29

TRANSISTORS

QTY	1	100	1000
PART #			
2N2222A	.20	.18	.15
2N3055	.55	.50	.45
2N3904	.05	.045	.035
2N3906	.05	.045	.035
2N4124	.09	.07	.045
2N4125	.09	.07	.045
2N4126	.09	.07	.045
2N4401	.05	.045	.035
2N4403	.05	.045	.035
2N5086	.09	.07	.045
2N5087	.08	.06	.04
2N5088	.08	.06	.04
2N5089	.09	.07	.045
2N5209	.09	.07	.045
2N5210	.09	.07	.045
2N5400	.12	.10	.065
2N5550	.12	.10	.065
2N5551	.09	.07	.045
BU806	1.10	.80	.70
MJE3055T	.65	.55	.44
MPSA-05	.10	.08	.05
MPSA-10	.12	.09	.06
MPSA-13	.15	.11	.075
MPSA-14	.15	.11	.075
MPSA-42	.14	.105	.07
MPSA-44	.22	.18	.12
MPSA-56	.10	.08	.05
MPSA-63	.45	.34	.22
MPSA-92	.12	.09	.06
MPSA-93	.15	.11	.075
MPSH-10	.12	.09	.06
MPSH-81	.44	.33	.21
PN2222A	.05	.045	.035
PN2907A	.05	.045	.035
TIP30	.42	.37	.32
TIP31	.42	.37	.32
TIP41	.49	.44	.39
TIP112	.56	.51	.46
TIP122	.57	.52	.47
TIP125	.53	.48	.43
TIP126	.56	.51	.46

VOLTAGE REGULATORS

QTY	1	100	1000
PART #			
7805	.48	.45	.42
7812	.48	.45	.42
7824	.48	.45	.42
7905	.61	.55	.49
7912	.61	.55	.49
7924	.61	.55	.49
78L05	.35	.31	.26
78L12	.35	.31	.26
79L05	.35	.31	.26
79L12	.35	.31	.26
LM317T	.95	.82	.68
LM350T	2.05	1.70	1.35

CRYSTALS

QTY	1	100	1000
HC18 case			
1.8432	.89	.67	.45
2.0000	.74	.55	.39
3.5795	.74	.55	.39
3.6864	.74	.55	.39
4.0000	.74	.55	.39
4.9152	.74	.55	.39
5.0688	.74	.55	.39
7.3728	.74	.55	.39
10.000	.74	.55	.39
11.000	.74	.55	.39
11.059	.74	.55	.39
12.000	.74	.55	.39
14.3181	.74	.55	.39

frequencies are in MHZ·

SWITCHES

QTY	1	100	1000
DIP STYLE			
4 POS.	.68	.58	.48
6 POS.	.77	.67	.57
8 POS.	.80	.70	.60
10 POS.	.95	.85	.75
TOGGLE			
SPDT	.62	.52	.40
SPDT-off	.73	.63	.49
DPDT	.69	.59	.46
DPDT-off	.86	.76	.59
PUSH BUTTON			
N. open	.28	.24	.20
N. closed	.29	.25	.21

All toggle and push button switches fit in a ¼" panel hole

LED's

QTY	1	100	1000
3MM			
RED	.06	.05	.04
GREEN	.07	.06	.045
YELLOW	.08	.07	.05
5MM			
RED	.06	.05	.04
GREEN	.07	.06	.045
YELLOW	.08	.07	.05
BI-COLOR	.29	.22	.17
BLUE	1.20	1.10	.95
BLINKER			
RED 5mm	.65	.53	.41
HOLDERS			
3mm	.10	.07	.055
5mm	.10	.07	.055

IC SOCKETS

QTY	1	100	1000
REGULAR			
8 PIN	.04	.035	.025
14 PIN	.08	.063	.045
16 PIN	.10	.08	.055
18 PIN	.11	.085	.06
20 PIN	.12	.095	.07
24 PIN	.15	.115	.08
28 PIN	.17	.13	.09
32 PIN	.20	.155	.11
40 PIN	.24	.185	.13
MACHINE			
8 PIN	.16	.135	.11
14 PIN	.28	.24	.185
16 PIN	.32	.27	.21
18 PIN	.36	.30	.235
20 PIN	.40	.33	.26
24 PIN	.48	.40	.32
28 PIN	.56	.47	.37
32 PIN	.64	.53	.42
40 PIN	.80	.66	.52
WIRE WRAP			
8 PIN	.32	.29	.26
14 PIN	.56	.51	.46
16 PIN	.64	.58	.52
18 PIN	.72	.66	.59
20 PIN	.80	.73	.65
24 PIN	.96	.87	.78
28 PIN	1.12	1.02	.91
32 PIN	1.28	1.16	1.04
40 PIN	1.60	1.45	1.30

BRIDGE RECTIFIER

QTY	1	100
IN LINE		
RS101 1A-50V	.60	.33
RS106 1A-800V	.93	.52
3N256 2A-400V	.95	.53
TL400 4A-50V	.65	.37
TU600 6A-50V	1.02	.65
TU800 8A-50V	1.33	.75
8 PIN DIP		
DF005M 1A-50V	.25	.18
DF10M 1A-1KV	.52	.33
ROUND		
W04M 1A-400V	.35	.17
2W10M 2A-1KV	.50	.27
SQUARE WIRE LEADS		
TB305 3A-50V	.53	.30
TB805 8A-50V	.93	.52
SQUARE TAB LEADS		
TB151 15A-100V	2.30	1.35
TB352 35A-200V	2.68	1.50

special pricing available for quantity over 500pcs.

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QTY	100	1000	5000
4" LENGHT	2.00	7.00	30.00
8" LENGHT	4.00	25.00	98.00

1Lb SOLDER ROLL

.031" diameter

SN60/40

$6.50 each

RESISTORS

ANY STANDARD VALUE

QTY	50	1000	5000
¼ W 5%	.80	7.00	28.00

These are prices for total quantity of same value. No mixing.

D-SUB CONNECTORS

QTY	1	100	1000
SOLDER CUP			
DB9 m.	.29	.22	.15
DB9 f.	.29	.22	.15
DB15 m.	.35	.27	.19
DB15 f.	.37	.29	.21
DB25 m.	.53	.37	.21
DB25 f.	.57	.42	.26
RIGHT ANGLE			
DB-9 m.	.49	.39	.30
DB-9 f.	.49	.39	.30
DB15 m.	.54	.44	.33
DB15 f.	.54	.44	.33
DB-25 m.	.69	.54	.49
DB-25 f.	.69	.54	.39
PLASTIC HOOD FOR DB			
DB-09	.26	.195	.13
DB-15	.29	.24	.19
DB-25	.31	.26	.21
DB-37	.53	.43	.34

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DX-40	0K	138.00
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SLC2-66		260.00
DX-40	128K	286.00
DX2-50	128K	351.00
DX2-66	256K	416.00
PENTIUM™		
PCI 60 MHZ		975.00
PCI 90 MHZ		1,375.00

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9600 bps	59.00
14.4K bps	86.00
28.8K bps	279.00

VGA CARDS

ISA 256K	38.00
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HCM-427E 14"

SUPER VGA MONITOR

1024 X 768 .28mm

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DOUBLE SPEED INT.

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The Next Generation Contact Cleaners, Conditioners and Preservatives

Even the finest equipment cannot guarantee noise-free operation. One "dirty" connection anywhere in the signal path can cause unwanted noise, distortion and signal loss. Considering the hundreds (if not thousands) of connections in electronic equipment today, it is only a matter of time before they begin to fail.

***ProGold** and **DeoxIT** increase the performance and reliability of electrical components and equipment. They provide long-lasting protection, reducing the expense of repeated cleaning with expensive ozone-depleting solvents. As a general rule, use **ProGold** for best performance and protection on plated surfaces and **DeoxIT** as a general purpose treatment.*

ProGold™ Conditioner & Preservative

ProGold outperforms all other contact cleaners, enhancers and lubricants. Due to its unique properties, not only does it deoxidize and clean surface contamination, but it penetrates plated surfaces and molecularly bonds to the base metals. This increases conductivity and contact surface area and reduces arcing, RFI, wear and abrasion - the major cause of intermittent signals, distortion and signal loss. ***ProGold** is the only product that conditions & protects plated surfaces and their base metals.*

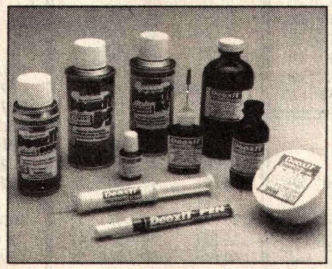
Environmentally-Safe!

Environmentally-Safe!

Environmentally-Safe!

DeoxIT™ & PreservIT™

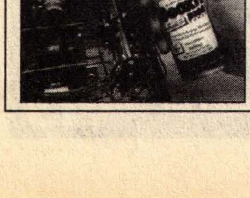
Deoxidizes, Seals & Protects Electrical Connections

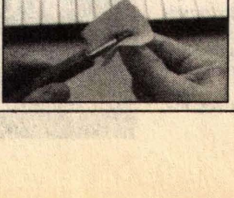


DeoxIT is a fast-acting, deoxidizing solution that cleans, preserves, lubricates & improves conductivity on all metal surfaces. Use as a general treatment for connectors, contacts & other metal surfaces.

PreservIT seals, lubricates and preserves metal surfaces for protection from oxidation and contamination. For use on clean/new surfaces or those pre-cleaned with ***DeoxIT***.

Both have excellent migration properties that coat the surfaces and protect them from future oxidation & contamination. These formulas contain improved deoxidizers, preservatives, conductivity enhancers, anti-tarnishing compounds, arcing & RFI inhibitors and provide extended temperature range.





Environmentally-Safe!

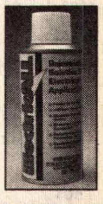
OpticALL™ StaticALL™

OpticALL cleans, polishes and eliminates static electricity on optical viewing surfaces. OpticALL is also recommended as a general purpose antistatic cleaner on plastic, glass and metal surfaces. **StaticALL** neutralizes static build-up caused by friction & low humidity conditions. Use on carpets, floors, clothing & other static generating surfaces.

DustALL™ FreezALL™

DustALL quickly & safely removes dust, lint & particles from sensitive electronic equipment, computers, lab equip., optical grade surfaces & other mechanisms & equipment. **FreezALL**quickly and safely cools circuits to -54°C. Locates intermittent components due to heat failure and hairline cracks on PCBs.

MechanicALL™



High Penetrating Anti-Corrosive Anti-Tarnishing Cleaner & Lubricant. Lubricates & Protects, Displaces Moisture, Stops Squeaks, Migrates & Coats Entire Surface.

ElectricALL™

Rejuvenating Solution For All Electrical Applications. Cleans, Preserves, Improves & Protects Connections, Removes Corrosion & Oxidation, Reduces Wear, Abrasion, Arcing & RFI.

CaiKleen™ 41

Approved Freon TF replacement. Cleaning solvent for equipment and parts. Harmless to metal and most plastics & elastomeric parts. No residue, non-flammable, HCFC blend.

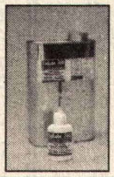
CaiKleen™ TRP

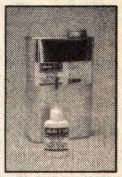
For degreasing, cleaning & defluxing equipment and parts. Removes oil, grease, dirt and contaminants including rosin flux from PCBs, components and metal parts. Biodegradable.

CaiKleen™ IPA

Ultra-pure isopropyl alcohol. Cleaning & degreasing solvent for removal of oil, grease & dirt from instruments, equipment & parts. Use on tape heads, discs, guides, switches, connectors, relays, and other parts for general cleaning.

CaiLube™ 360





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Contains silicone. Finest quality instrument oil for use on rubber, plastics and metals. Non-gumming, rust inhibiting, long lasting lubrication.

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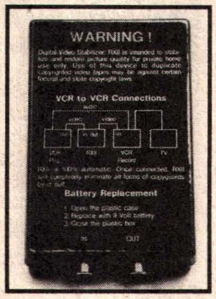
BLACK FEATHER ELECTRONICS

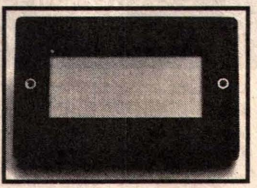
RXII VIDEO STABILIZER!


WARNING !
Digital Video Stabilizer: RXII is intended to stabilize and restore picture quality for private home use only. Use of this device to duplicate copyrighted video tapes may be against certain federal and state copyright laws.
VCR to VCR Connections
Battery Replacement
1. Open the plastic case
2. Replace with 9 Volt battery
3. Close the plastic box
IN
OUT

Get clear videos every time! Enjoy a clear picture with pure color and clarity on all your rented video tapes. The RXII VIDEO STABILIZER eliminates darkening and shifting of colors, unwanted lines and flashing or jagged edges caused by copyguards. State of the art integrated circuitry completely eliminates all copy protection and jamming signals. The RXII is ultra compact and fully automatic. Just pop in one 9V battery (not included) and hook it up! Compatible with all VCRs and TVs.

CAT # VS-1 **$29.00 each**

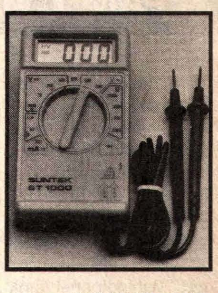
PANEL METER



This meter has many useful applications such as Voltmeter, Thermometer, Db Meter, Watt Meter, Current Meter, Capacitance Meter, Lux Meter and LCR Meter. Features include: 200mV fullscale input sensitivity, single 9VDC operation and decimal point selectable. In addition, it has 13mm figure height, automatic polarity indication, guaranteed zero reading for 0 volt input and high input impedance (>100M ohms). Specifications: Max input 199.9mV DC-Max. Display:1999 counts (3-1/2 digits). Measuring method: Dual slope integration A-D converter system, plus many other features.

CAT# PM-1 **$17.00 each**

DIGITAL POCKET MULTIMETER

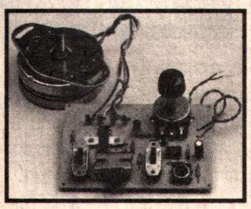

SUNTEK
ST1000

- **3 1/2 Digit LCD Display**
- **AC & DC Volts**
- **DC Current**

This little gem comes with many fancy features considering its compact size! Light weight and hand held, this unit also tests batteries and diodes. Great for the technician, student and hobbyist alike! SPECIFICATIONS: DC Volts: 2-500V, AC Volts: 200-500V, DC Current: 200mA, Resistance: 2K-OHMS-2MEG.OHMS, Diode Test: 3.2V Max 1=1mA (Diode), Battery Test: 1.5V AA (40mA) – 9V (24mA)

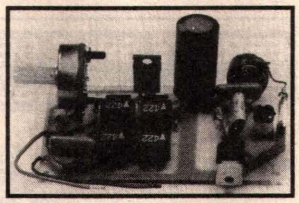
CAT# DMM-01 **$19.95 each**

STEPPER MOTOR CONTROLLER KIT



This kit allows you to adjust the speed and direction of a stepper motor. You can move the motor in one step increments or rotate it at a constant speed. There are a set of visual indicators that show the sequence of motion. Includes stepper motor, pc board, parts and instructions. (12vdc power source not included.) CAT# SMK-1 **$25.00 each**

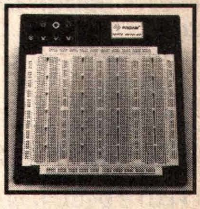
STROBE KIT



This kit allows you to vary the rate of strobe flashes 60 to 120 flashes per minute. Operating voltage is adjustable depending on how you wire the kit. It will work on 4.5, 6 and 12 VDC. Includes pc board, parts and instructions.

CAT #SLK-1 **$7.50 each**

BREADBOARDS



Breadboards allow you to design and prototype circuits quickly. It lets you position components on the board without soldering. Great for the experimenter, student and hobbyist! This breadboard is a large size board with enough room to design major projects. It measures: 7" x 9" and has 4 terminal strips, 7 distribution strips, and 4 binding posts mounted on an aluminum back plate.

CAT# BB-2 **$35.00 each**

CAMCORDER VIDEO TAPES

HI-8 120 MINUTE VIDEO CASSETTE TAPES (used)

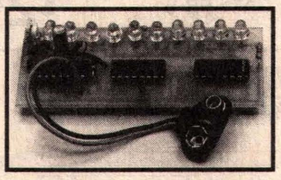
SONY
Hi8
120
P6-120HMPX

They were recorded on once and played only a few times. Made by a major brand name manufacturer. Professional series metal tapes. Includes plastic jewel box.

CAT# CCT-1 **$3.00 each**
10 or more – 2.80 each

BACK-FORTH FLASHERS

WOW! An Eye-Catching Delight!

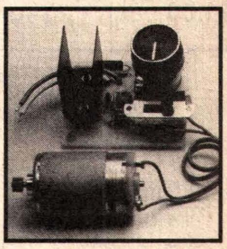


Great for special effects and other high tech applications. The flash speed is variable and can be set to go in one direction only. Requires one 9V battery (not included).

CAT# 10-02 **$6.50 each**

DC MOTOR SPEED CONTROLLER KIT

Easy To Build!



This kit allows you to control the speed and direction of a 6 to 12 volt motor. It is easy to build and includes pc board, motor, parts and instructions.

CAT # MSC-1 **$15.00 each**

REGULAR CAMCORDER TAPE

120 MINUTE VIDEO CASSETTE TAPE (used)

SONY
MP120
NTSC
Video8

Major brand name manufacturer, recorded on once and played only a few times. Excellent condition! These will play on a regular camcorder, where the HI-8 tapes don't. If you have a regular camcorder machine then this is the tape for you. If you have an HI-8 machine, you may enjoy the higher quality provided by the HI-8 tapes. Includes plastic jewel box.

CAT# CCT-2 **$2.50 each**
10 or more – 2.30 each

PRINTED CIRCUIT BOARD TRANSFER FILM

For LASER PRINTERS And PHOTOCOPIERS

PRINTED CIRCUIT BOARD TRANSFER FILM
4 Easy Steps!
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3. Peel-Off
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Easy Hobby Quality PCB's
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Eliminate darkrooms, photochemicals, negatives, and copy cameras! Make printed circuit boards using a laser printer or photocopier, direct from CAD software or magazines. Only four easy steps: 1. Print or copy; 2. Iron-on; 3. Peel-off, 4. Etch!

CAT# TEK-1 **$10.95**
package of 5

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1. **California residents must include sales tax.**
2. **Checks and money order accepted.**
3. **Quantities limited – prices subject to change without notice.**

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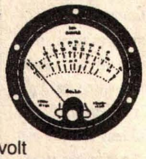
100 MicroAmp PANEL METER



Large, 4.5" diameter Mil-Spec panel meter. 3.5" dia. viewing area. Zero adjustment knob. White face. Scales in green, black and blue letters. Three AC and three DC volt scales; 0-2.5, 5 and 10. One resistance scale from 0 to infinity. Includes mounting hardware, rubber gasket. 1.25" behind panel depth.

CAT# MET-42 **$7.50 each**

ALUMINUM KNOBS

6 FLUTE DESIGN W/ INDICATOR LINE

Alcoknob # KA700B1/4
0.75" diameter X 0.63".
6-32 set screw.

CAT # KNB-73

$1.00 each • 25 for $ 18.75

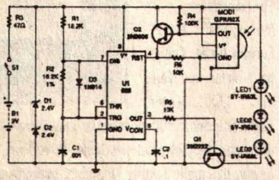
3 FLUTE DESIGN W/SKIRT AND INDICATOR LINE

Alcoknob # KS 500B1/4
0.5" dia. knob with 0.75" dia. skirt.
0.63" high. 6-32 set screw.

CAT # KNB-75

$1.00 each • 25 for $ 18.75

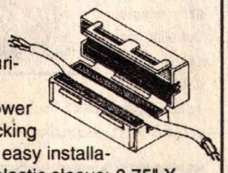
BUILD AND TEST LOGIC CIRCUITS ON YOUR COMPUTER



LogicLab Explorer™ version 2.1 Develop and test digital logic circuits using LogicLab DOS compatible software. This new revised edition turns your computer into a simulated parts cabinet, wire-wrap board and logic analyzer. Design circuits before spending money on parts.
3 1/2" diskettes.

CAT# LL-21 **$59.95 each**

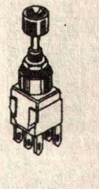
FERRITE SPLIT BEAD W/ PLASTIC SNAP SLEEVE



Clamps onto power cord. Suppresses RFI, EMI and unwanted spurious signals. Fits most round SVT and SJT power cords. 0.28" id. Self-locking plastic snap sleeve for easy installation. Dimensions with plastic sleeve: 0.75" X 0.75" X 1.29" long.

CAT# FB-9 **$2.00 each**

MINIATURE D.P.D.T. PUSH/ON PUSH/OFF



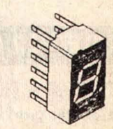
Augat/Alcoswitch # MPE206N Miniature DPDT, push/on push/off switch. Splashproof: O-ring on shoulder and inside movable shaft provides moisture seal. Rated 6 amps @ 125 Vac. RED 0.4" dia. cap. 0.25" threaded bushing. 0.8" behind panel depth. Solder lug terminals. UL and CSA listed.

CAT # MPB-20

$2.50 each

25 for $53.75 ($2.15 each)

7 SEGMENT DISPLAY



SPECIAL PRICING! **HDSP-7803**

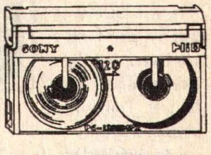
GREEN, 0.35" high character. Common cathode. RH decimal point. Gray background. Mount in two 5 pin SIP sockets.

3 for $1.00 **CAT# SDY-11**

100 for $25.00

"HI-8" VIDEO CASSETTE (USED)

8 mm Video Camcorder Users!.

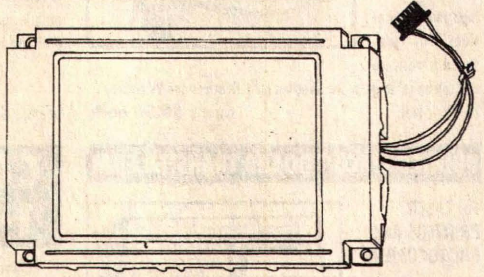


SONY Hi-8 T-120 Top quality, metal particle 120 minute video cassettes. Used for a short time, then bulk-erased, each cassette has its own plastic storage box. New, these high quality cassettes sell for considerably more. Satisfaction Guaranteed.

CAT# VCU-8 **$3.00 each**

10 for $28.00 • 100 for $250.00

640 X 480 DOT LCD DISPLAY



Sharp # LM64P70
Brand new 640 X 480 dot LCD flat panel display with on board high speed drivers and built-in CCFT backlight (inverter not included). Logic voltage: 5 Vdc. LCD driver voltage: -16.2 Vdc. Viewing area 6.8" X 5.1". Overall module size: 10.1" X 6.23" X 0.33". These displays sold for over $300.00 new. Includes specs. and hook-up information.

CAT # LCD-17 **$45.00 each**

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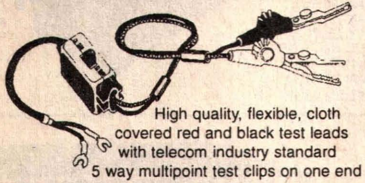
5 WAY MULTI-POINT TEST LEADS



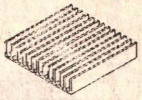
High quality, flexible, cloth covered red and black test leads with telecom industry standard 5 way multipoint test clips on one end and spade lugs on the other end. 5 ways to connect clips: 1) U-shaped nose for qc terminals; 2) Notched jaw for gripping screws, wires or terminals; 3) Serrated teeth for threaded or wire wrap terminals; 4) Cluster of small needles for piercing small gauge wires; 5) Large piercing needle for piercing larger wires. 4 feet long. At one end of the cord is a 1500 ohm resistor that can be switched in and out of circuit.

$3.50 per set

CAT# TL-200

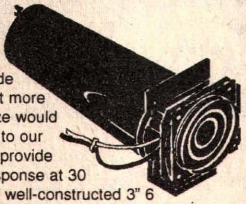
MICROPROCESSOR HEATSINK

Wakefield 1.5" square X 0.25" high black anodized aluminum heatsink for 15 X 15 PGA type chips. 13 vertical fins for maximum cooling efficiency.



CAT # HS-38 **$1.50 each**

3" SPEAKER W/ BAFFLE



We don't know the original application for these speakers, but they're well made and will handle a lot more power than their size would indicate. According to our primitive tests they provide good mid range response at 30 watts or better. The well-constructed 3" 6 ohm speaker has a heavy magnet and a foam-edged paper cone. It's conservatively rated at 7 watts, but the 7" deep, fiberglass filled baffle enables it to sound good at much higher power. Give them a try for car or home applications.

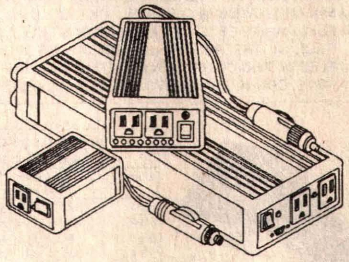
$6.00 EACH

CAT # SK-31

INVERTERS

RUN YOUR COMPUTER, TV, STEREO, POWER TOOLS FROM 12 VDC POWER SOURCE. IDEAL EMERGENCY BACK-UP POWER. PERFECT FOR CARS, BOATS, PLANES AND RVS.

Lightweight, solid-state power inverters from "Power-To-Go" provide continuous 115 volts, 60 Hz +OR- 5%. Features audible low battery alarm (10.6 volts), low battery shutdown (10 volts), high temperature shutoff (150 deg.F), and high surge current capability to start difficult loads such as lamps, motors and other inductive loads.



140 WATT CONTINUOUS POWER

200 watt peak power. Single outlet. Cigarette lighter plug.

CAT# PC-140 $65.00

300 WATT CONTINUOUS POWER

500 watt peak power. Two AC outlets. Cigarette lighter plug. Built-in cooling fan.

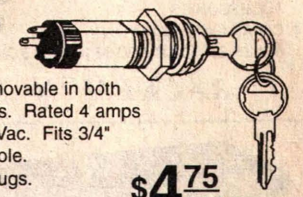
CAT# PC-300 $129.00

600 WATT CONTINUOUS POWER

1000 watt peak power. Two AC outlets. Built-in cooling fan. Stud terminal inputs. Includes 6' long 10 gauge power cables with color-coded alligator clips for direct connection to battery.

CAT# PC-600 $279.00

SPDT KEYSWITCH



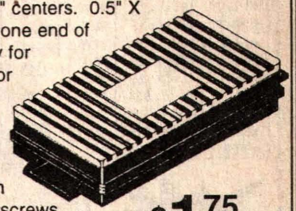
C&K
F series
SPDT
(on-on).
Key removable in both positions. Rated 4 amps @ 125 Vac. Fits 3/4" round hole. Solder lugs.

$4.75 EACH

CAT# KSW-10

BULKHEAD MOUNT CHASSIS BOX

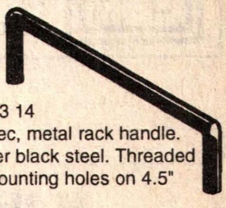
Black, break-resistant plastic chassis box, originally designed for an auto alarm. 5.18" X 3.36" X 1.25". Box has a matte black finish with a ribbed top and mounting flanges with holes on 5.5" centers. 0.5" X 2.25" slot in one end of box is handy for power cord or wiring harness. Two halves of box screw together with sheet metal screws (screws not provided).



$1.75 EACH

CAT# MB-31

RACK HANDLE



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Good quality, mil spec, metal rack handle. Black, 5/16" diameter black steel. Threaded for 10-32 screws. Mounting holes on 4.5" centers.

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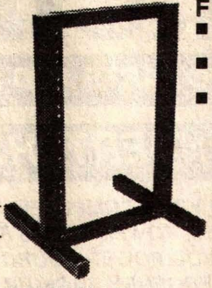
- CLEAR FINISH STANDARD, FOR BLACK OR GOLD ADD $5.00 PER BOX

Boxes		
MODEL	DESCRIPTION W x H x D (IN.)	PRICE $
RSB-3	7.5 x 1.65 x 3	25.00
RSB-5	7.5 x 1.65 x 5	31.25
RSB-7	7.5 x 1.65 x 7	38.00
RSB-9	7.5 x 1.65 x 9	45.00
RSB-11	7.5 x 1.65 x 11	51.50
RSB-13	7.5 x 1.65 x 13	58.25

NEW



FEATURES:

- FOUR MODELS AVAILABLE IN HALF AND FULL RACK WIDTHS
- CLEAR, BLACK AND GOLD ANODIZED FINISHES
- CONSTRUCTED OF 1.0" SQUARE ALUMINUM TUBING

Table Top Racks		
MODEL	DESCRIPTION W x H x D (IN.)	PRICE $
RSR-6	11.5 x 15.2 x 11.25	60.00
RSR-8	11.5 x 18.8 x 11.25	65.00
RSR-10	11.5 x 22.6 x 11.25	70.00
RSR-12	11.5 x 26.4 x 11.25	75.00
RSR-6-19	21.0 x 15.2 x 11.25	70.00
RSR-8-19	21.0 x 18.8 x 11.25	75.00
RSR-10-19	21.0 x 22.6 x 11.25	80.00
RSR-12-19	21.0 x 26.4 x 11.25	85.00

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RACK CHASSIS
PANELS ARE .063" ALUMINUM; STANDARD FRONT AND REAR PANELS ARE CLEAR ANODIZED, BLACK OR GOLD PANELS ALSO AVAILABLE FOR ADDITIONAL $5.00

Rack Chassis		
MODEL	DESCRIPTION W x D x H (in)	PRICE $
1RU5	19 x 5 x 1.75	34.00
1RU7	19 x 7 x 1.75	36.50
1RU10	19 x 10 x 1.75	38.75
★1RU12	19 x 12 x 1.75	42.75
★1RU15	19 x 15 x 1.75	45.75
★1RU17	19 x 17 x 1.75	48.75
2RU5	19 x 5 x 3.5	36.50
2RU7	19 x 7 x 3.5	38.75
2RU10	19 x 10 x 3.5	41.25
★2RU12	19 x 12 x 3.5	45.25
★2RU15	19 x 15 x 3.5	48.25
★2RU17	19 x 17 x 3.5	51.25
3RU5	19 x 5 x 5.25	46.00
3RU7	19 x 7 x 5.25	48.50
3RU10	19 x 10 x 5.25	51.00
★3RU12	19 x 12 x 5.25	54.00
★3RU15	19 x 15 x 5.25	57.00
★3RU17	19 x 17 x 5.25	60.00

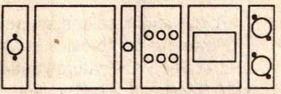
NEW SIZES

Dual Slope Cabinets		
MODEL	DESCRIPTION W x D x H (in)	PRICE $
DS-1	4 x 6 x 4	40.00
DS-2	6 x 6 x 4	43.00
DS-3	8 x 6 x 4	46.00
DS-4	10 x 6 x 4	49.00
DS-5	12 x 6 x 4	52.00
DS-6	18 x 6 x 4	55.00
DS-7	4 x 8 x 6	50.00
DS-8	6 x 8 x 6	54.00
DS-9	8 x 8 x 6	58.00
DS-10	10 x 8 x 6	62.00
DS-11	12 x 8 x 6	66.00
DS-12	18 x 8 x 6	70.00

LOWER PRICES!

DUAL SLOPE CABINET
PANELS ARE .063" ALUMINUM

BOX-IT™ SYSTEM



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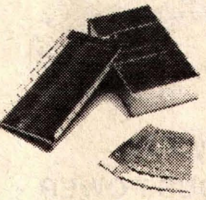
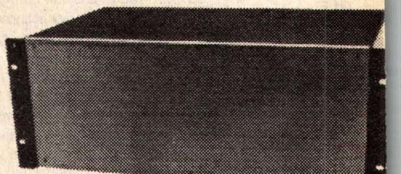


RF SHIELDED BOXES
HOT TIN-PLATED STEEL

RF Shielded Steel Boxes		
MODEL	DESCRIPTION L x W x H (inches)	PRICE $
SB-1	2.1 x 1.9 x 1.0	4.50
SB-2	3.3 x 1.9 x 1.0	6.00
SB-3	4.2 x 1.9 x 1.0	9.00
SB-4	6.3 x 1.9 x 1.0	10.50
SB-5	3.3 x 2.7 x 1.1	9.50
SB-6	4.8 x 2.7 x 1.1	11.50
SB-7	6.4 x 2.7 x 1.1	13.20
SB-8	2.6 x 2.7 x .63	7.00
SB-9	3.2 x 2.7 x .63	8.25
SB-10	4.8 x 2.7 x .63	9.00
SB-11	6.3 x 2.7 x .63	10.75
FTS-1	1000 pF/50VDC SOLDER TYPE	.85
FTSI-1	1000 pF/50VDC SCREW-IN TYPE	3.50

PERFECT FOR RF AND CLOCK TYPE CIRCUITS AND ALLOW THE ELIMINATION OF SPILLOVER OF UNWANTED SIGNALS. THE BOXES COME WITH DIVIDERS AND THE LIDS CAN BE SOLDERED TO THE CASE. 1000 pF/50VDC FEED THRU CAPACITORS ARE AVAILABLE AS SOLDER OR SCREW-IN TYPES.

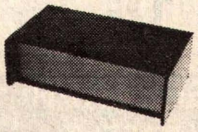


HEAVY DUTY RACK CHASSIS
PANELS ARE .080" ALUMINUM AND ARE FIELD REMOVABLE; STANDARD FRONT & REAR PANELS ARE CLEAR ANODIZED, BLACK PANELS AVAILABLE FOR ADDITIONAL $15.00

Metal Cabinets		
MODEL	DESCRIPTION W x D x H (in)	PRICE $
MC-1A	4 x 3 x 2	12.00
MC-2A	6 x 3 x 2	14.00
MC-3A	8 x 3 x 2	16.00
MC-4A	4 x 5 x 3	14.00
MC-5A	6 x 5 x 3	16.00
MC-6A	8 x 5 x 3	18.00
MC-7A	4 x 7 x 4	16.00
MC-8A	6 x 7 x 4	18.00
MC-9A	8 x 7 x 4	20.00

LOWER PRICES!

Heavy Duty Rack Chassis		
MODEL	DESCRIPTION W x D x H (in)	PRIC $
3RU7 HD	19 x 7 x 5.25	120.7
3RU10 HD	19 x 10 x 5.25	127.0
3RU14 HD	19 x 14 x 5.25	140.7
4RU7 HD	19 x 7 x 7.0	127.0
4RU10 HD	19 x 10 x 7.0	135.5
4RU14 HD	19 x 14 x 7.0	140.7
5RU7 HD	19 x 7 x 8.75	132.2
5RU10 HD	19 x 10 x 8.75	139.7
5RU14 HD	19 x 14 x 8.75	150.2



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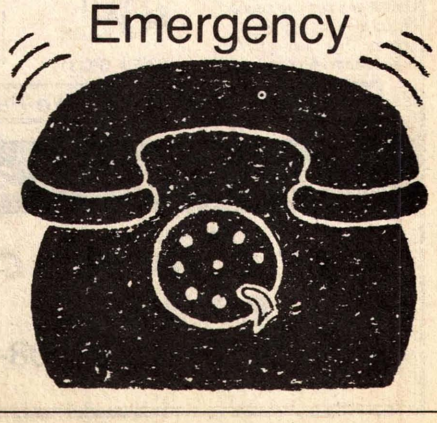

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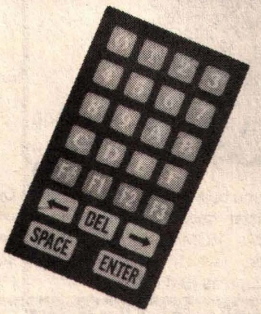

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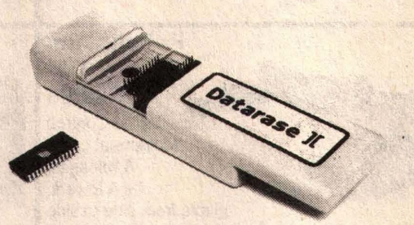

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- Erases most EPROM's/EPLD's in 3 minutes
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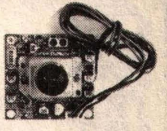

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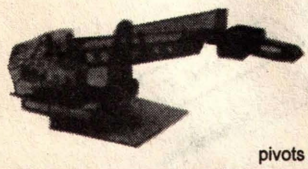

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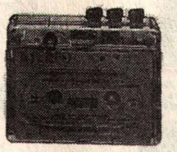

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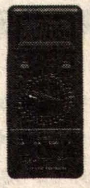

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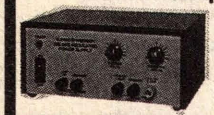

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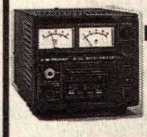

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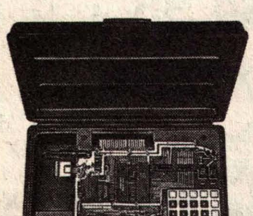

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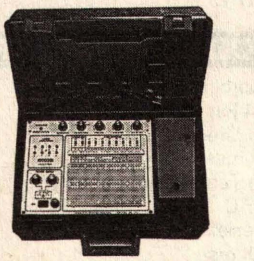

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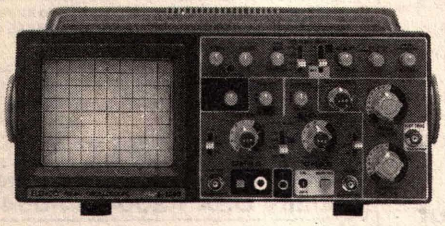


60MHz

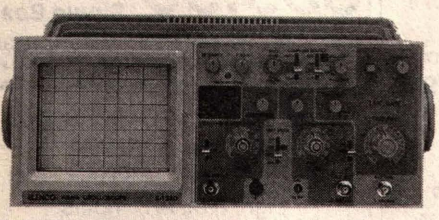
S-1360 $775

Delayed Sweep

S-1365 $849

Cursor Readout

- Voltage, Time
- Frequency differences displayed on CRT



40MHz

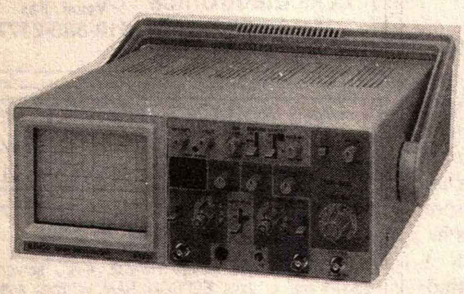
S-1340 $495

2- Channel

S-1345 $575

Delayed Sweep

- Beam Find
- Component Tester



25MHz

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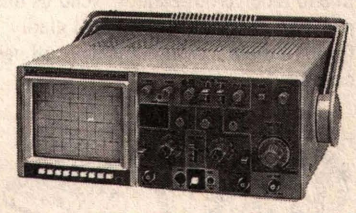

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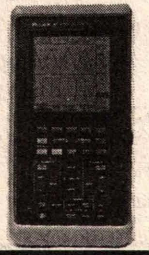

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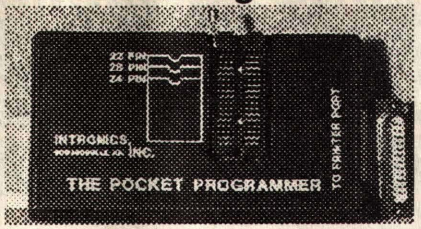

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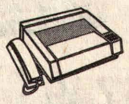

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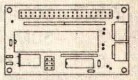

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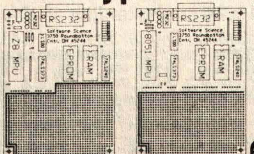

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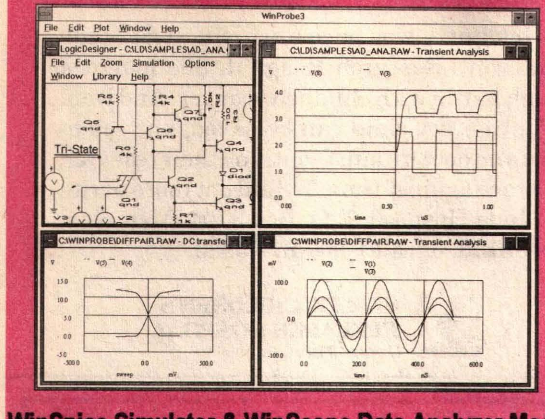
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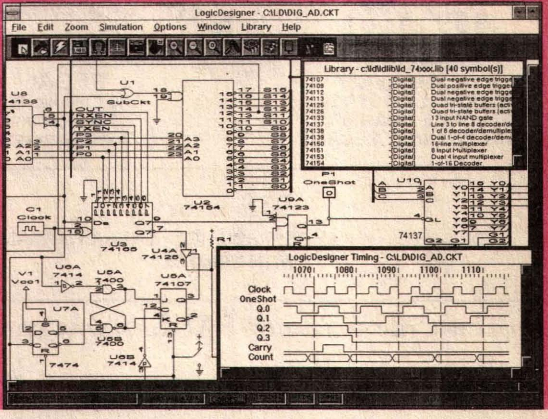
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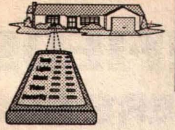

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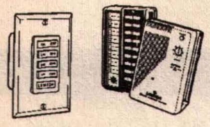

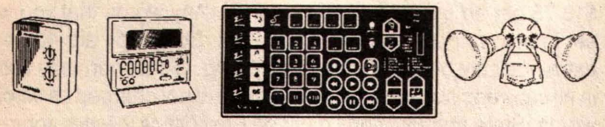

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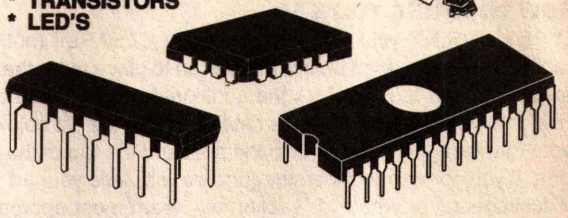

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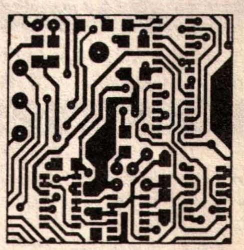

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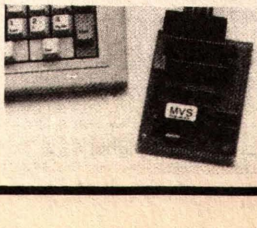

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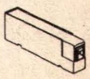
High brightness red laser visible for up to a mile. Use in many projects such as light shows, holography, and laser eavesdropping. Output: 1.0-1.8mW; Class IIIa. Size: 6.25" x 1.4" x 2.25"



12Vdc operation	$49.00
120VAC operation- includes adaptor	$59.00

Visible Laser Diode Module

This is one of the smallest laser modules available. Perfect for weapons sights, alignment, demonstrations, etc. Output: 4.7mW Red (670 nm). 3 Vdc operation. Cylindrical brass housing. 9 inch leads. Size: 21mm L x 11mm diameter. Cat. # VM-12 **$69.50 each**

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INSTRUCTION FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for the additional ads (a photocopy of this form works well). Choose a category from the list below and write that category number into the space at the top of the order form. If you do not specify a category, we will place your ad under Miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. Payment in full must accompany your order. We do permit repeat ad or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first two words of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $1.25 per word. Minimum charge is $18.75 per ad per insertion (15 words). Any words that you wan set in bold or caps are 20¢ each extra. Bold caps are 40¢ each extra. Indicate bold words by underlining. Words normally writte in all caps and accepted abbreviations are not charged as all-caps words. State abbreviations must be Post Office 2-letter abbreviations. A phone number is one word.

CONTENT

All classified advertising in the **Electronic Shopper** is limited to electronics items only. All ads are subject to the publisher's approval. We reserve the right to reject or edit all ads.

DEADLINES

Ads received by our closing date will run in the next issue. For example, ads received by April 1 will appear in the July, 1993 issue that is on sale in June 3. Shopper ads will appear Jan., Mar., May etc. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

AD RATES: $1.25 per word, Minimum $18.75.

Send your ads with payment to:
Electronic SHOPPER, 500-B Bi-County Blvd. Farmingdale, NY 11735

CATEGORIES

100 — Antique Electronics
130 — Audio-Video-Lasers
160 — Business Opportunities
190 — Cable TV
210 — CB-Scanners
240 — Components
270 — Computer Equipment Wanted
300 — Computer Hardware
330 — Computer Software
360 — Education
390 — FAX
420 — Ham Gear For Sale
450 — Ham Gear Wanted
480 — Miscellaneous Electronics For Sale
510 — Miscellaneous Electronics Wanted
540 — Music & Accessories
570 — Plans-Kits-Schematics
600 — Publications
630 — Repairs-Services
660 — Satellite Equipment
690 — Security
710 — Telephone
720 — Test Equipment

CLASSIFIED AD COPY ORDER FORM

Ad No. 1—Place this ad in Category # ______

1 - $18.75	**2** - $18.75	**3** - $18.75	**4** - $18.75
5 - $18.75	**6** - $18.75	**7** - $18.75	**8** - $18.75
9 - $18.75	**10** - $18.75	**11** - $18.75	**12** - $18.75
13 - $18.75	**14** - $18.75	**15** - $18.75	**16** - $20.00
17 - $21.25	**18** - $22.50	**19** - $23.75	**20** - $25.00
21 - $26.25	**22** - $27.50	**23** - $28.75	**24** - $30.00
25 - $31.25	**26** - $32.50	**27** - $33.75	**28** - $35.00
29 - $36.25	**30** - $37.50	**31** - $38.75	**32** - $40.00
33 - $41.25	**34** - $42.50	**35** - $43.75	**36** - $45.00
37 - $46.25	**38** - $47.50	**39** - $48.75	**40** - $50.00

Ad No 1—Total words ________ × $1.25 per word = $ ________
All Caps words ________ × .20 per word = $ ________
Bold words ________ × .20 per word = $ ________
Bold Cap words ________ × .40 per word = $ ________
TOTAL COST OF AD No. 1 $ ________

Total classified ad Payment $ ________ enclosed.

[ ] Check [ ] MasterCharge [ ] Visa ($18.75 minimum credit card order)

Card # __ __ __ __ __ __ __ __ __ __ __ __ __ __ __

Expiration Date __ __ / __ __
Signature ________________

Name ________________ Phone ________________

Address ________________ City State Zip ________________

BIG News!! - B² LOGIC® v 3.0 IS HERE!!! - BIG News!!

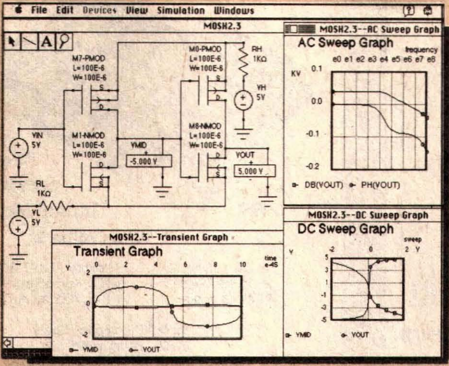
ANALOG & DIGITAL

Circuit Design & Simulation

for **Microsoft Windows™** and the **Macintosh™**

B² Spice
v.1.1

NEW RELEASE B² Logic®
v.3.0


File Edit Devices View Simulation Windows
MOSH2.3
M7-PMOD L=100E-6 W=100E-6
M0-PMOD L=100E-6 W=100E-6
RH 1KΩ
VH 5V
VIN 5V
M1-NMOD L=100E-6 W=100E-6
VMID -5.000 V
M8-NMOD L=100E-6 W=100E-6
VOUT 5.000 V
RL 1KΩ
VL 5V
MOSH2.3--AC Sweep Graph
AC Sweep Graph
frequency
e0 e1 e2 e3 e4 e5 e6 e7 e8
KV 0.1 0.0 -0.1 -0.2
DB(VOUT) PH(VOUT)
MOSH2.3--DC Sweep Graph
DC Sweep Graph
sweep
-2 0 2 V
5 3 1 -1 -3 -5
VMID VOUT
MOSH2.3--Transient Graph
Transient Graph
time e-4S
0 2 4 6 8 10
2 0 -2
VMID VOUT

TRANSIENT, DC & AC ANALYSES

What is B² Logic 3.0?

B² Logic v.2.2 + EDIF File Format Output + Enhanced PLD Sim. Cap. + New Devices (inc. binary-to-seven segment decoder and one shot) + Print Across Mult. Pgs. + Subcircuit Probing + Table For Sim. Results + Model Primitives with User Def. Prop. + Mult. Document Interface in Microsoft Windows + Rotate Comp. + Check For Fan-Out Violations + More Accurate Power Calc. + Check For Max PulseWidth Violation + more!

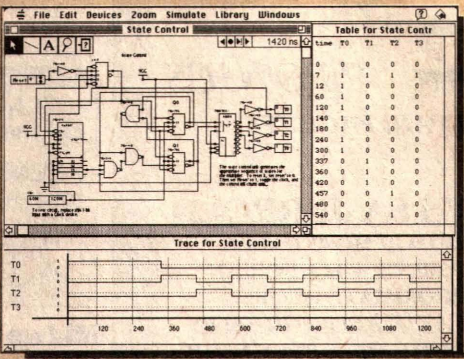

File Edit Devices Zoom Simulate Library Windows
State Control
1420 ns
Trace for State Control
T0 T1 T2 T3
120 240 360 480 600 720 840 960 1080 1200

Table for State Contr

time	T0	T1	T2	T3
0	0	0	0	0
7	1	1	1	1
12	1	0	0	0
60	1	0	0	0
120	1	0	0	0
140	1	0	0	0
180	1	0	0	0
240	1	0	0	0
300	1	0	0	0
337	0	1	0	0
360	0	1	0	0
420	0	1	0	0
457	0	0	1	0
480	0	0	1	0
540	0	0	1	0

B² Logic v.3.0... Check it out!!!

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"Using B² Logic ... my students have been able to learn more, and go much further than ever before."
-Professor F.S. Hill, Jr. University of Massachusetts, Amherst

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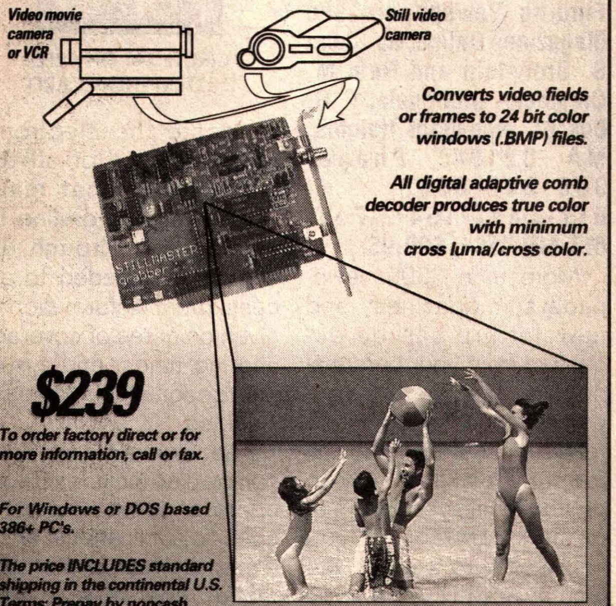
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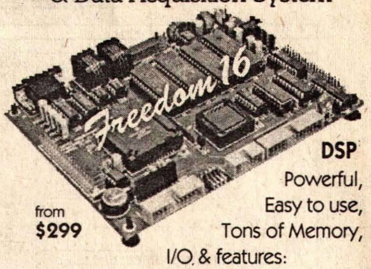

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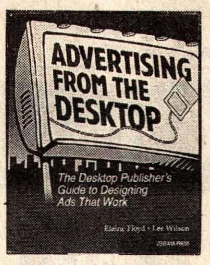
Advertising From the Desktop: The Desktop Publisher's Guide to Designing Ads That Work; by Elaine Floyd and Lee Wilson. Ventana Press, P. O. Box 2468, Chapel Hill, NC 27515; Phone: 919-942-0220; Fax: 919-942-1140.

This book explains how to turn a personal computer into a versatile advertising design and publishing tool. It relies on time-tested advertising techniques and dozens of illustrations to explain how to create a solid marketing plan and build product recognition through consistent attractive promotion.

Among the subjects covered are how to target an audience, how to arouse reader curiosity, emotion, and interest with the right visuals, and how to create layouts that command attention and sell products. Information is given on the selection of type faces and the design of headlines and logos that attract attention.


ADVERTISING FROM THE DESKTOP
The Desktop Publisher's Guide to Designing Ads That Work
Elaine Floyd • Lee Wilson

CIRCLE 345 ON FREE INFORMATION CARD

Many different kinds of sales materials can be generated on a personal computer, including display ads, small-space ads, and direct-mail pieces. Floyd and Wilson provide guidance on creating your own business stationery, advertising premiums, labels, signs, displays, and promotional shopping bags.

Other topics covered are advertising with a fax machine, pre-recorded diskettes, bulletin boards, audio recordings, and multimedia presentations. Listings are given for software and services as well as books and periodicals related to PC advertising and promotion. Also listed are professional associations, consultants, training programs, free catalogs, and print services.

CompuServe Companion: Finding Newspapers and Magazines Online; by Glenn S. Orenstein and Ruth M. Orenstein. Bibliodata, P. O. Box 61, Needham Heights, MA 02194; Phone: 800-247-6553 or 617-444-1154; Fax: 617-449-4584; $29.95.

More than 3300 newspapers, magazines, and newsletters can be accessed from your personal computer. CompuServe provides access to full-text reference material that was formerly available only to professional subscribers of on-line services. If you know how to access the CompuServe system, you can read *Forbes* magazine or "clip" an article from *The Los Angeles Times* the day after it is published.

This book explains how to locate the electronic transcriptions of all the publications that make them available on-line by guiding you through the commands needed to access them. Information is given on dates of coverage and lag times, and a subject/geographic indexes is included.

COMPUSERVE COMPANION:
FINDING NEWSPAPERS AND MAGAZINES ONLINE
GLENN S. ORENSTEIN
RUTH M. ORENSTEIN
BIBLIODATA

CIRCLE 346 ON FREE INFORMATION CARD

The CompuServe companion also includes the GO commands that lead to specific publications, and it explains which of the commands cost less to use. The book will save money by explaining how to access information with methods that do not call for surcharges. Ω

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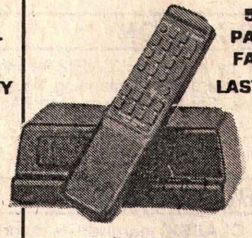

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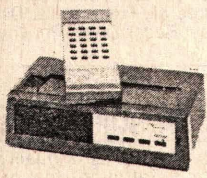

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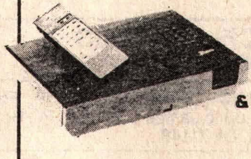

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CRYSTAL SET Handbook — Visit antiquity by building the radios your grandfather built. Assemble a "Quaker Oats" rig, wind coils that work and make it look like the 1920's! Only $10.95 plus $3.50 for shipping and handling. Electronic Technology Today, Inc., PO Box 240, Massapequa Park, NY 11762-0240. US funds only! USA and Canada — no foreign orders.

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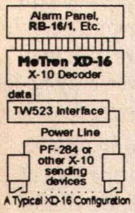
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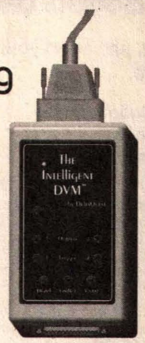

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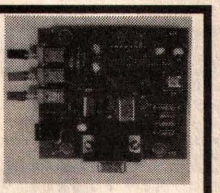

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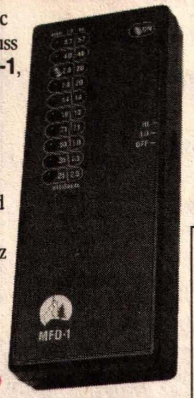

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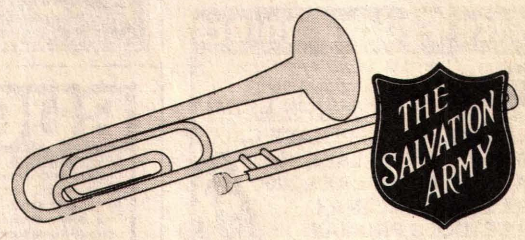

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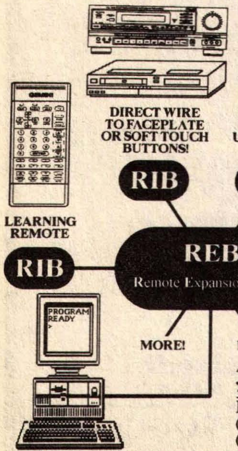

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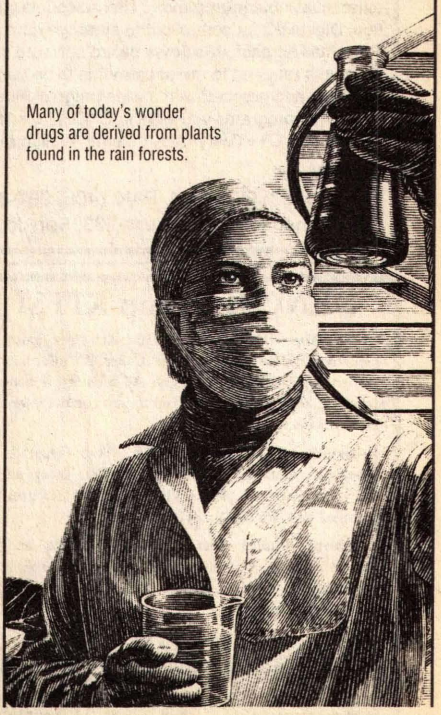

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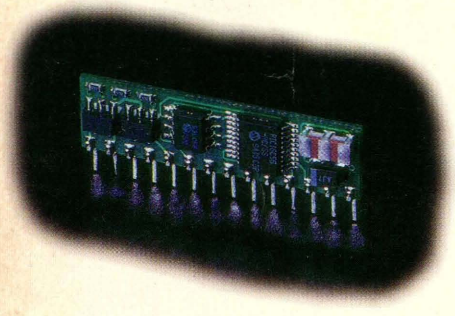

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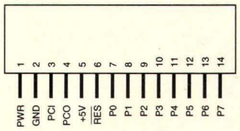
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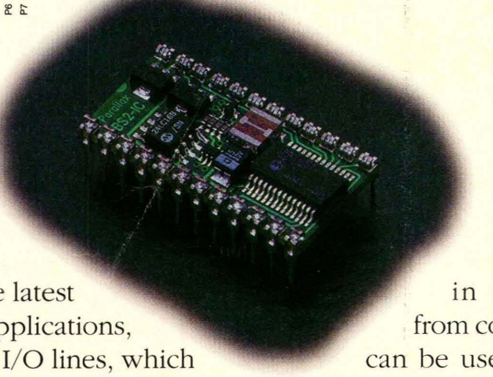

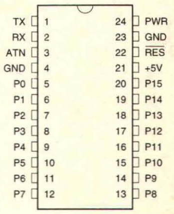
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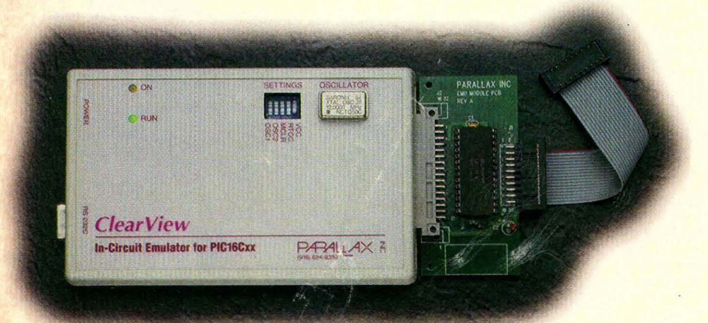
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ClearView
In-Circuit Emulator for PIC16Cxx
PARALLAX

ClearView™ In-Circuit Emulators

20-MHz in-circuit debugging for PIC16C5x/64/71/84/...
Set breakpoints, step through code, and modify registers.
Friendly DOS and Windows software.
$499 each! (separate units for "5x" and "xx" PICs)

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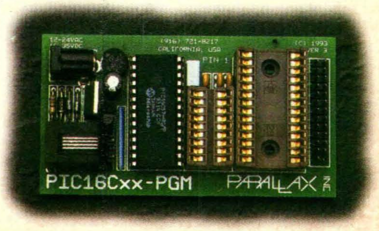
Programmer for PIC16C5x/64/71/74/84/...
Documentation on disk.
User-supplied cables and power supply.
Just $99!


PIC16Cxx-PGM
PARALLAX

PARALLAX INC®

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(916) 624-8333 • Fax: 624-8003 • BBS: 624-7101

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DC-2000 MHz

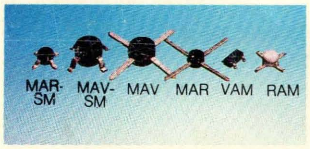
AMPLIFIERS

In plastic and ceramic packages, for low-cost solutions to dozens of application requirements, select Mini-Circuits' flatpack or surface-mount wideband monolithic amplifiers. For example, cascade three MAR-2 monolithic amplifiers and end up with a 25dB gain, 0.3 to 2000MHz amplifier for less than $4.50. Design values and circuit board layout available on request.

It's just as easy to create an amplifier that meets other specific needs, whether it be low noise, high gain, or medium power. Select from Mini-Circuits' wide assortment of models (see Chart), sketch a simple interconnect layout, and the design is done. Each model is characterized with S parameter data included in our 740-page RF/IF Designers' Handbook.

All Mini-Circuits' amplifiers feature tight unit-to-unit repeatability, high reliability, a one-year guarantee, tape and reel packaging, off-the-shelf availability, with prices starting at 99 cents.

Mini-Circuits' monolithic amplifiers...for innovative do-it-yourself problem solvers.



Models above shown actual size

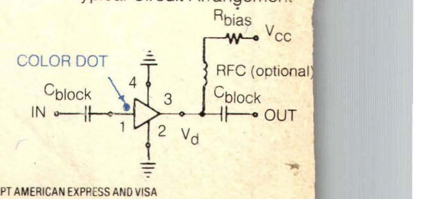
from **99¢** Unit price $ (25 qty)

PLASTIC SURFACE-MOUNT			++VAM-3 1.45		+VAM-6 1.29	++VAM-7 1.75		
add suffix SM to model no. (ex. MAR-ISM)	MAR-1 1.04	MAR-2 1.40	MAR-3 1.50	MAR-4 1.60	MAR-6 1.34	MAR-7 1.80	MAR-8 1.75	
	MAV-1 1.15	+MAV-2 1.45	+MAV-3 1.55	MAV-4 1.65				MAV-11 2.15
CERAMIC SURFACE-MOUNT	RAM-1 4.95	RAM-2 4.95	RAM-3 4.95	RAM-4 4.95	RAM-6 4.95	RAM-7 4.95	RAM-8 4.95	
PLASTIC FLAT-PACK	MAV-1 1.10	+MAV-2 1.40	+MAV-3 1.50	+MAV-4 1.60				MAV-11 2.10
	MAR-1 0.99	MAR-2 1.35	MAR-3 1.45	MAR-4 1.55	MAR-6 1.29	MAR-7 1.75	MAR-8 1.70	
Freq.MHz,DC to	1000	2000	2000	1000	2000	2000	1000	1000
Gain, dB at 100MHz	18.5	12.5	12.5	8.3	20	13.5	32.5	12.7
Output Pwr. +dBm	1.5	4.5	10.0	12.5	2.0	5.5	12.5	17.5
NF, dB	5.5	6.5	6.0	6.5	3.0	5.0	3.3	3.6

Notes: + Frequency range DC-1500MHz ++ Gain 1/2 dB less than shown

designer's kit, KH-1 available only $59.95 includes:
40 AMPLIFIERS* 10 MAR-1, 10 MAR-3, 10 MAR-4, 10 MAR-8
150 CAPACITORS* 50 100 pf, 50 1,000 pf, 50 10,000 pf
740 page RF/IF DESIGNER'S HANDBOOK
• MIXERS • POWER SPLITTER/COMBINERS • AMPLIFIERS • ELECTRONIC ATTENUATOR
• I&Q/QPSK MODULATORS • ATTENUATORS/TERMINATIONS • DIRECTIONAL COUPLER
• RF TRANSFORMERS • DIGITAL ATTENUATORS • PHASE DETECTORS • SWITCHES/DRIVER
• FILTERS • LIMITERS • FREQUENCY DOUBLERS
*values or models may be substituted without notice, depending on supplies.

Typical Circuit Arrangement



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setting higher standards

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